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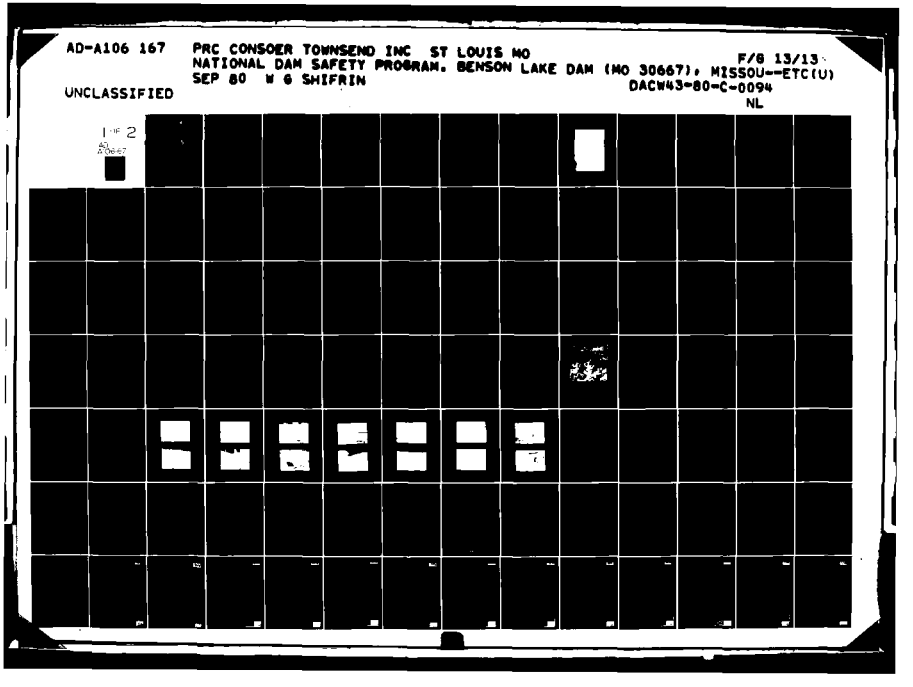

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MISSOURI · KANSAS CITY RIVER BASIN

BENSON LAKE DAM
GASCONADE COUNTY, MISSOURI
MO. 30667

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

SEPTEMBER, 1980

UNCLASSIFIED

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Dam Safety, Lake, Dam Inspection, Private Dams

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This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD NORTH
ST. LOUIS, MISSOURI 63101

SUBJECT: Benson Lake Dam Dam (Mo. 30667) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Benson Lake Dam (Mo. 30667).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass 50 percent of the Probable Maximum Flood
2) Overtopping could result in dam failure
3) Dam failure significantly increases the hazard to loss of life downstream

SUBMITTED BY: _____ _____
Chief, Engineering Division Date

APPROVED BY: _____ _____
Colonel, CE, District Engineer Date

BENSON LAKE DAM
GASCONADE COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30667

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
CONSOER, TOWNSEND AND ASSOCIATES, LTD.
ST. LOUIS, MISSOURI
AND
PRC ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO
A JOINT VENTURE

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

SEPTEMBER 1980

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Benson Lake Dam, Missouri Inv. No. 30667
State Located: Missouri
County Located: Gasconade
Stream: An unnamed tributary of the Frene Creek
Date of Inspection: April 24, 1980

Assessment of General Condition

Benson Lake Dam was inspected by the engineering firms of Consoer, Townsend and Associates, Ltd. and PRC Engineering Consultants, Inc. (A Joint Venture) of St. Louis, Missouri according to the U. S. Army Corps of Engineers "Engineer Regulation No. 1110-2-106" and additional guidelines furnished by the St. Louis District of the Corps of Engineers. Based upon the criteria in the guidelines, the dam is in the high hazard potential classification, which means that urban development with more than a small number of habitable structures could be affected in the event of failure of the dam. Within the estimated damage zone of three miles downstream of the dam are one dwelling, four buildings, two trailors, an oil depot, sewage lagoons and a state highway (Hwy 100) which may be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Benson Lake Dam is in the small size classification since it is less than 40 feet in height and impounds less than 1000 acre-feet of water.

In general, the dam appears to be in poor condition. Our inspection and evaluation indicates that the spillway of Benson Lake Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Benson Lake Dam being a small size dam with a high hazard potential is required by the guidelines to pass from one-half of the Probable Maximum Flood to the Probable Maximum Flood without overtopping. Considering the number of inhabited dwellings, a state highway, and an oil depot being located downstream of the dam, the PMF is considered the appropriate spillway design flood for Benson Lake Dam. It was determined that the reservoir/spillway system can accommodate approximately 20 percent of the Probable Maximum Flood without overtopping the dam. ~~Our~~ evaluation also indicates that the reservoir/spillway system can accommodate the one-percent chance flood (100-year flood) without overtopping.

The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

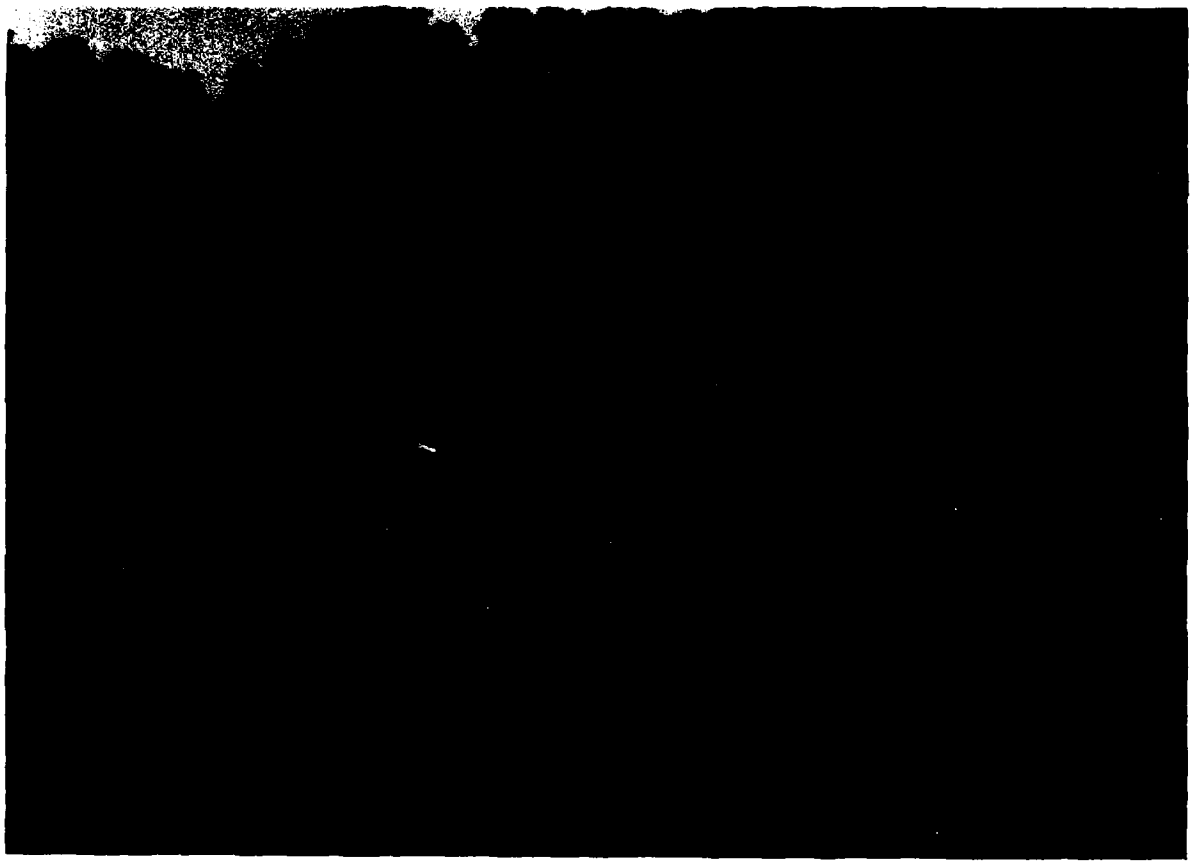
Another major deficiency with Benson Lake ~~Dam~~ is the three scarps observed on the downstream slope on the left side of the embankment and the seepage observed in the area. Two of the scarps were fairly shallow and approximately 3-feet wide. The other scarp was approximately 20-feet wide at the top and 30 feet wide at the bottom. These scarps and the seepage indicate instability of the slope.

Other deficiencies noted by the inspection team were the minor wave erosion on the upstream slope, the trees on the upstream and the downstream embankment slopes, the tall vegetation on the embankment, rodent activity on the embankment, the erosion on the left side slope of the spillway channel, tall grass growing within

the spillway channel, a need for periodic inspection by a qualified engineer and a lack of maintenance schedule. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take immediate action to study the embankment seepage and stability problem and correct or control the several deficiencies described above in the near future.

Walter G. Shifrin, P.E.



Overview of Benson Lake Dam

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

BENSON LAKE DAM, I.D. No. 30667

TABLE OF CONTENTS

TABLE OF CONTENTS

(Continued)

TABLE OF CONTENTS

(Continued)

LIST OF PLATES

APPENDICES

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

BENSON LAKE DAM, Missouri Inv. No. 30667

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Benson Lake Dam was carried out under Contract DACW 43-80-C-0094 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of Consoer, Townsend & Associates, Ltd., and PRC Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of Benson Lake Dam was made on April 24, 1980. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, presents a summary of visual observations made during the field inspection, presents an assessment of hydrologic and hydraulic conditions at the site, presents an assessment of the structural adequacy of the various project features and assesses the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that in this report reference to left or right abutments is viewed as looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the west abutment or side, and right to the east abutment or side.

d. Evaluation Criteria

The inspection and evaluation of the dam is performed in accordance with the U.S. Army Corps of Engineers "Engineer Regulation No. 1110-2-106" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase 1 Dam Inspection.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The following description is based upon observations and measurements made during the visual inspection and from conversations with Wilbur Benson, a representative of the owner. Design drawings were not located for the dam or appurtenant structures.

The dam is an earthfill structure between earth abutments. The crest has a total length of 277 feet between the spillway and the right abutment. The maximum crest elevation is approximately 712 feet above mean sea level (MSL) at a point 100 feet to the right of the spillway. The crest elevation drops 6 inches from this point to the spillway and 2 feet from this point to the right abutment. The dam has a somewhat curved alignment convex in the downstream direction. The crest width is 12 feet. The maximum height of the embankment from the downstream creekbed is approximately 25 feet. The upstream slope was measured to be 1 vertical to 3 horizontal (1V to 3H) from the crest to the water surface. The downstream slope was measured to be 1V to 2H. No riprap was provided as slope protection on the upstream slope.

The spillway is constructed into the left abutment and functions as an open channel. The approachway provides a smooth transition from the lake to the spillway channel. Once over the crest the invert slope is approximately 1%. The crest area cross-section is trapezoidal in shape with a 68 foot top width and a 45 foot bottom width. The channel bottom has a small subchannel at its invert which carries most of the flow for normal conditions; this subchannel is four inches deep with a 5 foot top width. The spillway channel has a 1.5

foot drop about 100 feet downstream from the crest. Approximately 50 feet downstream from the drop the alignment has a sharp curve to the right before it empties into the downstream channel. There is about 50 feet of channel between the sharp curve and the downstream channel. Downstream from the 1.5 foot drop, the slope of the invert increases and the width of channel decreases.

The right rim of the reservoir is parallel to a road and both the rim and the road are at a lower elevation than the top of dam. Before the dam could be overtopped, water would spill over this right rim and into the roadway. This condition causes the right reservoir rim especially at the right abutment to serve as an emergency spillway. The roadway at the right abutment is approximately 2.5 feet lower than the top of dam at its maximum section, whereas the spillway crest is almost 4 feet lower than the top of dam elevation at its maximum section.

There are no low level drains or mechanically controlled outlet works provided for this dam.

b. Location

Benson Lake Dam is located in in the State of Missouri, Gasconade County, and crosses an unnamed tributary to Frene Creek, which is tributary to the Missouri River. The damsite is approximately five miles southwest of Hermann, a community on the Missouri River, and can be found on the 7.5 minute series of the Hermann, Mo. Quadrangle Sheet in Section 15 of Range 5 West and Township 45 North.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Department of the Army, Office of the Chief Engineer, the dam is classified in the dam-size category as being "small" since its storage is less than 1,000 acre-feet. The dam is also classified as "Small" in the dam-size category because its height is less than 40 feet. The overall size classification is therefore "Small".

d. Hazard Classification

The dam has been classified as having a "High" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. Our findings concur with this classification. Within the estimated damage zone, which extends approximately three miles downstream of the dam, are one dwelling, four buildings, two trailers, an oil depot, sewage lagoons, and a state highway.

e. Ownership

Benson Lake Dam is owned privately by Mr. Clifford Benson. The mailing address is Mr. Clifford Benson, R.R. 1, Box 82, Hermann, Missouri 65041.

f. Purpose of Dam

The purpose of the dam is to impound water for recreational use as a private lake.

g. Design and Construction History

According to a neighbor, Mr. A.C. Schneider, the dam was built in 1966 (est.) by Mr. Glennon Epple of Hermann, Missouri. Efforts to contact the original builder were futile.

Mr. Elmer Kuhn, who was the soil conservationist for the Hermann, Missouri area, assisted with the initial planning for the dam. However, the dam wasn't built according to Mr. Kuhn's recommendations. The height of the dam and spillway were raised and the spillway width was decreased. The local Soil Conservation Service office doesn't have any records concerning Benson Lake. Benson Lake Dam was originally called Schneider Lake Dam.

h. Normal Operational Procedures

The dam is used to impound water for recreational use. Normal procedure is to allow the lake to remain as full as possible with the water level being controlled by rainfall, runoff, evaporation and the elevation of the spillway crest.

1.3 Pertinent Data

a. Drainage Area (square miles): 0.23

b. Discharge at Damsite

Estimated experienced maximum flood (cfs): 300

Estimated ungated spillway capacity with reservoir at top of dam elevation (cfs): 338

c. Elevation (feet above MSL)

Top of dam (minimum):. 710

Spillway crest:. 708.2

Normal Pool: 708.2

Maximum Experienced Pool 710-

Observed Pool: 708.2

d. Reservoir

Length of pool with water surface at top of dam (minimum) elevation (feet):. 1000

e. Storage (Acre-Feet)

Top of dam (minimum) 20

Spillway crest:. 14

Normal Pool: 14

Maximum Experienced Pool:. 20-

Observed Pool: 14

f. Reservoir Surfaces (Acres)

Top of dam (minimum):. 4.4

Spillway crest:. 3

Normal Pool: 3

Maximum Experienced Pool:. . . . . 4+

Observed Pool: 3

g. Dam

Type:	earthfill
Length:	227 feet
Structural Height:	25 feet
Hydraulic Height:	25 feet
Top width:	12 feet
Side slopes:	
Downstream	1V to 2H
Upstream	1V to 3H (crest to water surface)
Zoning:	Unknown
Impervious core:	Unknown
Cutoff:	Unknown
Grout curtain:	Unknown

h. Diversion and Regulating Tunnel — None

i. Spillway

Type:	Trapezoidal open channel, uncontrolled
Length of crest:	45 feet (Bottom width)
Crest Elevation (feet above MSL):	708.2

j. Regulating Outlets — None

SECTION 2: ENGINEERING DATA

2.1 Design

Design drawings or calculations are not available for the dam.

2.2 Construction

The dam was built by Mr. Glennon Epple of Hermann, Missouri. No construction records or data are available relating to the construction of the dam.

2.3 Operation

No operational records or data are available for the dam.

2.4 Evaluation

a. Availability

No design drawings, design computations, construction data, or operation data are available.

In addition, no pertinent data were available for review of hydrology, spillway capacity, flood routing through the reservoir, slope stability, seepage analyses, or foundation conditions.

b. Adequacy

The lack of engineering data did not allow for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation and construction data, but is based primarily on visual inspection, past performance history, and sound engineering judgement.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

No valid engineering data are available.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of the Benson Lake Dam was made on April 24, 1980. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Dr. M.A. Samad	PRC Engineering Consultants, Inc.	Project Engineer, Hydraulics and Hydrology
Mark R. Haynes	PRC Engineering Consultants, Inc.	Soils and Mechanical
Robert G. McLaughlin	PRC Engineering Consultants, Inc.	Civil
Razi Quraishi	PRC Engineering Consultants, Inc.	Geology
John Lauth	Consoer, Townsend & Assoc., Ltd.	Civil and Structural
Mr. Wilbur Benson	Representative of the Owner	

Specific observations are discussed below.

b. Dam

The dam crest supports an unmaintained vegetative cover which appears to be adequate protection against surface erosion. A comprehensive inspection of the crest was hampered due to the growth of vegetation. The curvature in the alignment and the crown in the crest do not appear to be due to an instability in the embankment. The dam was probably constructed this way. There was no evidence of significant settlement on the crest. No significant deviations in horizontal or vertical alignment were apparent. According to Mr. Wilbur Benson, the dam has never been overtopped and no evidence was observed indicating the contrary.

The upstream slope has no riprap protection. Some minor erosion due to wave action has occurred near the water surface. The slope above the water surface is adequately protected against surface erosion by a good growth of vegetation. No erosion gullies due to surface runoff were observed. Two trees were observed on the slope near the spillway. A comprehensive inspection of the slope was hampered due to the growth of vegetation. No settlements or bulges which would indicate an instability of the slope were apparent.

The downstream slope has a heavy growth of unmaintained vegetation which appeared to be adequate protection against surface erosion. No erosion due to surface runoff was observed. Considerable amount of trees were growing on the slope. In one area from approximately 50 feet to 100 feet to the right of the spillway, three scarps were observed. Two of the scarps were fairly shallow and approximately 3-feet wide. The other scarp was approximately 20-feet wide at the top and

30-feet wide at the bottom. The scarp extends from the toe of the dam to within 5 feet of the crest. The slope near the top of the scarp was near vertical. According to Mr. Benson, this area has been this way since 1977 when the Benson's took ownership of the property. Some indications indicate that the slough occurred fairly recently. The leaning of the young trees toward the slope in the area indicate that the slough had occurred fairly recently, however, grass has grown back on the steep sections of the scarp. Although seepage was observed on the slope in the area of the scarps, it was not possible to measure the flow rate for this investigation. Cattails were observed in the area which indicates that water (seepage) is present most of the time. No other depressions, bulges or cracks which would indicate an instability of the embankment were apparent on the slope.

Rodent activity was observed on the embankment. Several one inch diameter rodent holes were observed on the crest and the upstream slope. One large rodent hole was observed on the downstream slope. It was approximately 6 inches in diameter.

A small natural drainage channel was observed just downstream of the toe of the dam. The channel runs parallel to the embankment from the right abutment to the discharge channel of the spillway. The channel appeared to be used to drain the surface runoff of the right abutment area. Some flowing water was observed in the channel; however, it was not possible to determine whether or not this flow was due at least in part to seepage through the embankment or foundation.

Both abutments slope gently upward from the crest. No erosion which would affect the safety of the embankment or appurtenant structures was observed on either abutment. No seepage or instabilities which would affect the safety or stability of the dam were apparent on either abutment. The left abutment supports the spillway and the right abutment supports a gravel access road which runs perpendicular to the embankment. Rock outcrops were observed in the spillway discharge channel and on the right abutment.

c. Project Geology and Soils

(1) Project Geology

The damsite is located on an unnamed tributary of the Frene Creek in the Salem Plateau section of the Ozark Plateaus Physiographic Province. Deep dissection of topography by major streams is one of the important characteristics of the Salem Plateau section. There is a wide distribution of dolomites and limestones in the Salem Plateau. Cuestaform topography is exhibited in this plateau section, consisting of two major escarpments, namely the Crystal Escarpment and Burlington Escarpment. Deep dissection in dolomites and limestones is a major factor in the development of many springs in this area. The topography in the damsite vicinity is rolling to hilly with U to V shaped valleys. Elevation ranges from 927 feet above M.S.L. (nearly 0.5 miles northwest of the damsite) to 700 feet above M.S.L. at the Benson Lake. The reservoir slopes are generally 5^{o} to 18^{o} from horizontal. The reservoir appears to be watertight and free of any potential slide activity. The area at the damsite is covered with slope wash deposits of glacial-fluvial and loess in origin. These deposits consist of reddish-brown silty clay.

The inlet and outlet areas of the unnamed tributary of Frene Creek contain Quaternary Alluvium. Outcrops of Ordovician moderately weathered, hard Dolomitic rocks, horizontally interbedded with brown Calcareous sandstones and light gray shales, with a strike of N5OE are exposed at the base of the spillway cut and at the downstream channel of the spillway. Each unit of these rocks is three feet thick, with horizontal to blocky joint pattern.

The areal bedrock geology beneath the slope wash deposits as shown on the geologic map of Missouri (1979), Plate 3 consists of Pennsylvanian rocks undifferentiated, Ordovician St. Peter's sandstone and Ordovician Dolomitic rocks. No faults have been identified in the vicinity of the damsite. The closest trace of a fault is the Cuba Fault nearly 22 miles south of the damsite. The Cuba Fault had its last movement in post-Pennsylvanian time. This fault appears to have no effect on the damsite.

Benson Lake Dam consists of an homogeneous earthfill embankment and a spillway located at the right abutment end of the embankment. No boring logs or construction reports were available which would indicate foundation conditions encountered during the dam construction. It is assumed that the embankment probably rests on brownish-gray Calcareous sandstone interbedded with shales and dolomites. The spillway is cut into hard sandstone interbedded with shales and dolomites. The spillway rockcut slopes are relatively stable. Minor localized rock debris were observed at the foot of the slope at the downstream channel walls of the spillway.

(2) Project Soils

According to the "Missouri General Soil Map and Soil Association Descriptions" published by the Soil Conservation Service, the materials in the general area of the dam belong to the soil series of Gerald-Union-Goss in the Ozarks family. The soils were basically formed from loess and cherty limestone residuum. The permeability of these soils range from moderate to very slow.

Materials removed from the embankment on the upstream and downstream slopes approximately 1 foot below the vegetative cover appeared to be a light brown silty fine to medium sand. Based upon the Unified Soil Classification System, the soil probably be classified as a SM. This soil type generally has the following characteristics: semipervious to impervious with a coefficient of permeability less than 100 feet per year; medium to high shear strength; and a low to intermediate resistance to piping.

d. Appurtenant Structures

(1) Spillway

The banks of the spillway channel especially the left bank appear to be of easily erodible material as there are several erosion gullies forming along the slope. Although the channel is clear at the inlet area, the bottom of channel, a short distance downstream, becomes heavily laden with tall grass, bushes, and even a sapling or two. The bottom of channel seems to be in easily erodible soil also but, in an area where a rock outcropping occurs. There is much evidence of the erosion and rock downstream of the drop where the invert slope increases causing higher velocities. Sloughing

also seems to be present in this downstream portion. The entire bottom of channel is in bedrock through the sharp turn to the right and on down to the downstream channel.

(2) Outlet Works

There is no level drain or outlet works provided for this dam.

e. Reservoir Area

The water surface elevation was 708.2 feet above MSL on the day of the inspection. The reservoir rim is lined with trees along the right side which is also where a road runs adjacent to the reservoir. The remainder of the reservoir rim has mild grassy slopes. The slopes above the reservoir rim are mild and grass covered. The forested area begins a few hundred feet away from the reservoir rim. At least three drainage swales from the surrounding forest empty into the reservoir. There are no houses or other structures built in close proximity to the reservoir.

f. Downstream Channel

The downstream channel is well defined. The channel is 5 feet wide and 3 feet deep and has a side slope of 1V to 2H on the right side and 1V to 5H on the left side in the proximity of the damsite. Some trees and tall vegetation were observed growing on the channel. The trees and the tall vegetation will reduce the hydraulic efficiency of the channel.

3.2 Evaluation

The visual inspection did reveal one item which was significant enough to possibly warrant immediate remedial action. The scarps observed on the downstream slope indicate instability of the slope. The slope appeared to be stable at the time of the inspection, however, the potential of further sloughing of the slope is still there. The seepage observed in the area is also detrimental to safety and stability of the embankment. The seepage increases the potential for further failure in this area. The potential of the embankment to fail in this area is also increased if the dam is overtopped, the slope would probably erode faster in this area thus increasing the potential of failure. The embankment is also weaker in this area and the surcharge of water on the embankment as the reservoir level rises above the spillway crest could cause the embankment to fail.

The following conditions were observed which could affect the safety of the facility and will require maintenance within a reasonable period of time.

1. The minor wave erosion on the upstream slope does not appear to affect the stability of the dam in its present condition. Nevertheless, continual erosion of the slope could be detrimental to the stability of the dam.

2. The trees observed on the downstream and the upstream slopes pose a potential danger to the safety of the dam depending upon the extent of the root system. The roots of trees present possible paths for piping through the embankment. The root systems can also do damage to the embankment from being uprooted by a storm.

3. Rodent activities observed on the embankment could jeopardize the safety of the dam. The holes created by the animals make avenues for possible piping.

4. The vegetation on the embankment should be properly maintained. A heavy growth of vegetation on the embankment hinders a comprehensive inspection of the dam and potential problems could go undetected.

5. Although the spillway area does not seem to be in a condition that jeopardizes the safety of the dam, the following conclusions seem likely: (a) the erosion through the left bank will get worse and soil will be washed downstream if left in the "as is" condition, (b) the tall grass etc. growing within the channel slows the velocity of the flow thus causing some backwater effects, and (c) the channel banks downstream of the drop will continue to erode and slough into the bottom of channel.

6. If water overflows the roadway at the right abutment and flows down along the upstream right abutment contact, problems could arise due to a weakening between the dam and the abutment.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Benson Lake Dam is used to impound water from rainfall and runoff for recreation. The water level below the spillway crest is allowed to remain as high as possible.

4.2 Maintenance of Dam

The dam is maintained by the owner, Mr. Clifford Benson, and his brother, Mr. Wilbur Benson. The maintenance of the dam appears to be inadequate. The downstream slope is covered with dense vegetation, bushes, saplings and trees and on the upstream slope a few small trees and saplings are growing.

There is an erosion gully at the downstream side of the spillway. This erosion should be arrested before it can do any damage to the embankment.

There have not been any major repairs done to the dam since its original construction.

4.3 Maintenance of Operating Facilities

There are no operating facilities associated with this dam.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any existing warning system in effect.

4.5 Evaluation

The maintenance at Benson Lake Dam appears to be inadequate at this time. The remedial measures described in Section 7 should be undertaken to improve the condition of the dam.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

The watershed area of Benson Lake Dam upstream from the dam axis consists of approximately 147 acres. There is an upstream dam above Benson Lake Dam. The watershed area between the upstream dam and Benson Lake Dam investigated in this report is about 93 acres. Most of the watershed area is wooded with some range and pasture land. Land gradients in the watershed average roughly 7 percent. Benson Lake Dam is located on an unnamed tributary of Frene Creek. The reservoir is about 2-1/4 miles upstream from the confluence of the unnamed tributary and Frene Creek. At its longest arm the watershed is approximately 0.8 mile long. A drainage map showing the watershed, the downstream hazard zone, and location of the upstream dam is presented as Plate 1 in Appendix B.

Evaluation of the hydraulic and hydrologic features of Benson Lake Dam was based on criteria set forth in Corps of Engineers' "Engineer Regulation No. 1110-2-106", and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation (PMP) using the methods outlined in the U.S. Weather Bureau Publication, Hydrometerological Report No. 33. The probable maximum storm duration was set at 24 hours, and storm rainfall distribution was based on criteria given in EM 1110-2-1411 (Standard Project Storm). The SCS method was used for deriving the unit

hydrographs, utilizing the Corps of Engineers' computer program HEC-1 (Dam Safety Version). Two unit hydrographs were derived. One unit hydrograph was for the drainage above the Upstream Dam; another unit hydrograph was for drainage area between the Upstream Dam and Benson Lake Dam. The SCS method was used for determining loss rate. The hydrologic soil group of the watershed was determined by use of published soil maps. The hydrologic soil group of the watershed and the SCS curve number are also presented in Appendix B. The curve number, the unit hydrograph parameters, and the PMP rainfall were directly input to the HEC-1 (Dam Safety Version) computer program to obtain the PMF hydrograph. The computed peak discharges of the PMF and one-half of the PMF at the Upstream Dam reservoir are 1159 cfs and 579 cfs respectively. The peak discharges of the PMF and one-half of the PMF for the area between the Upstream Dam and Benson Lake Dam are 2026 and 1013 cfs respectively. Both the PMF and one-half of the PMF inflow hydrographs at the Upstream Dam were routed through the Upstream reservoir by the Modified Puls Method, also utilizing the HEC-1 (Dam Safety Version) computer program. A storm of 50 percent and 25 percent PMF, respectively, preceded the PMF and 50 percent PMF by four days. The reservoir was assumed at the mean annual high water level at the beginning of the antecedent storm. The mean annual high water level for the Upstream Dam was estimated to be at the crest of the spillway. The antecedent 50 percent PMF storm, when routed through the reservoir will leave the reservoir at the same elevation as the spillway crest at the end of four day period. Thus the reservoir was assumed at the crest level of the spillway at the start of the routing computation for PMF, one-half of the PMF and other PMF ratio floods. The failure elevation of the upstream dam was set at the minimum elevation of the top of dam. The breach dimension for the upstream dam was determined according to the guidelines furnished by the St. Louis Dis-

trict Corps of Engineers.

The peak outflow discharges with dam break for the PMF and one-half of the PMF at the Upstream Dam are 1091 cfs and 578 cfs, respectively. Both the PMF and one-half of the PMF when routed through the reservoir resulted in overtopping of the Upstream Dam. The outflow hydrographs at the Upstream Dam were routed through the channel between the Upstream Dam and Benson Lake Dam and then were combined with the PMF and one-half of the PMF hydrographs for Benson Lake Dam. The combined hydrographs for both the PMF and one-half of the PMF, were then routed through Benson Lake Dam reservoir. The reservoir was assumed at mean annual high water level at the beginning of the routing computation. The mean annual high water level for Benson Lake Dam Reservoir was estimated to be at the crest of the spillway. The peak outflow discharges for the PMF and one-half of the PMF at Benson Lake Dam are 2,887 cfs and 1,340 cfs, respectively. Both the PMF and one-half of the PMF, when routed through the reservoir resulted in overtopping of Benson Lake Dam.

The sizes of physical features utilized to develop the stage-outflow relation for the spillway and overtopping of the dams were prepared from field notes and sketches prepared during the field inspection. The reservoir elevation-area data were obtained from the U.S.G.S. Hermann, Missouri Quadrangle topographic map (7.5 minute series). The spillway and dam overtop-rating curve and the reservoir elevation-area curve for Benson Lake Dam are presented as Plates 2 and 3 in Appendix B.

From the standpoint of dam safety, the hydrologic design of a dam must aim at avoiding overtopping. Overtopping is especially dangerous for an earth dam because of its erodable characteristics. The safe hydrologic design of an embankment dam requires a spillway discharge capability combined with an embankment crest height that can handle a very large and exceedingly rare flood without overtopping.

The Corps of Engineers designs dams to safely pass the Probable Maximum Flood that could be generated from the dam's watershed. This is generally the standard for dam safety where overtopping would pose any threat to human life. Accordingly, the hydrologic requirement for safety for this dam is the capability to pass the Probable Maximum Flood without overtopping.

b. Experience Data

It is believed that records of reservoir stage or spillway discharge are not maintained for this site. However, according to Mr. Wilbur Benson, the maximum reservoir level was about a few inches above the roadway at the right abutment.

c. Visual Observations

Observations made of the spillway during the visual inspection are discussed in Section 3.1d(1) and evaluated in Section 3.2.

d. Overtopping Potential

As indicated in Section 5.1.a, both the Probable Maximum Flood, and one-half of the Probable Maximum Flood when routed through the reservoir, resulted in overtopping of the dam. The peak outflow discharges for the PMF are 2,887 and 1,340 cfs, respectively. The maximum capacity of the spillway just before overtopping the dam is 338 cfs. The PMF overtopped the dam by 2.33 feet and one-half of the PMF overtopped the dam by 1.35 feet. The total duration of overflow over the top of dam is 5.25 hours during the PMF and 1.17 hours during one-half of the PMF. The spillway/reservoir system of Benson Lake Dam is capable of accommodating a flood equal to approximately 20 percent of the PMF just before overtopping the dam. The reservoir/spillway system of Benson Lake Dam will accommodate the one-percent chance flood without overtopping.

The surface soils in the embankment and the spillway appear to be a sand-silt mixture. The dam is overtopped by over 2 feet during the occurrence of the PMF. The maximum velocity of flow in the spillway during the PMF will be about 8 ft/sec, which exceeds the permissible velocity (5 ft/sec) in the spillway. The dam itself would be susceptible to erosion due to high velocity of flow on its downstream slope, specially in the area of the scarps observed on the downstream slope, during overtopping of the dam.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The evidence of the past sloughing and the present seepage observed on the downstream slope indicates a serious instability and potential for failure of the embankment in the area of the observed scarps. Seepage was observed in the area of the scarps. The scarps and the seepage observed on the slope indicate instability of the slope. The minor erosion of the upstream slope due to wave action was not serious enough to constitute an unsafe condition. Nevertheless, the erosion should be monitored and if the erosion continues, steps should be taken to control the problem. No other major signs of settlement or distress were observed on the embankment or foundation during the visual inspection. In the absence of seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

The spillway crest area and the channel appear to be generally stable albeit in poor condition. The roadway, which will act as emergency spillway also appears to be in a stable condition.

b. Design and Construction Data

No design computations were uncovered during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction were available for use in a stability analysis.

c. Operating Records

No operating records are available relating to the dam or appurtenant structures. No regulated outlet works was provided for the dam. The water level on the day of the visual inspection was at the crest of the spillway. According to Mr. Wilbur Benson, the reservoir remains close to full at all times.

d. Post Construction Changes

No post construction changes are known to exist which will affect the structural stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 1, as defined in "Recommended Guidelines For Safety Inspection of Dams" as as prepared by the Corps of Engineers, and will not require a seismic stability analysis. An earthquake of the magnitude which would be expected in Seismic Zone 1 will not cause distress to a well designed and constructed earth dam.

Available literature indicates that no active faults exist near the vicinity of the damsite.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation, however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based upon observations of field conditions at the time of inspection along with data available to the inspection team.

It is also important to note that the condition of a dam depends upon numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be assurance that an unsafe condition could be detected.

a. Safety

The spillway capacity of Benson Lake Dam is found to be "Seriously Inadequate". The spillway/reservoir system will accommodate about 20 percent of the PMF without overtopping the dam. The surface soils in the embankment and the spillway appears to be a sand-silt mixture. The dam is overtopped by over 2 feet during the occurrence of the PMF. The maximum velocity of flow in the spillway during PMF will

be about 8 ft/sec. The velocity in the spillway will thus exceed the permissible velocity of 5 ft/sec (Kentucky Blue Grass-sandy silt). The dam would also be susceptible to erosion due to high velocity of flow on its downstream slope, due to overtopping of the dam during the occurrence of the PMF.

No quantitative evaluation of the safety of the embankment can be made in view of the absence of seepage and stability analyses. The present embankment, however, has reportedly performed satisfactorily since its construction without failure or evidence of instability, except for instability of the left side of the downstream slope. Reportedly, the dam has never been overtopped and there was no evidence indicating the contrary.

The safety of the dam can be improved if the deficiencies described in Sections 6.1a and 3.2 and below are properly corrected as described in Section 7.2. The trees observed on the downstream and upstream slopes pose a potential danger to the safety of the dam depending upon the extent of the root system. The roots of trees present possible paths for piping through the embankment. The root systems can also do damage to the embankment from being uprooted by a storm. Therefore, the trees should be removed from the embankment under the guidance of an engineer experienced in the design and construction of earthen dams.

The existence of burrowing animals on the embankment could jeopardize the safety of the dam. The holes created by the animals make avenues for possible piping. The extent of damage to the embankment done by the burrowing animals should be determined and corrective measures undertaken as required.

The spillway system seems to be functioning in a reasonably efficient manner and doesn't pose any hazards for the dam. The roadway at the right abutment, which will act as emergency spillway, was once overflowed during a flood. The roadway seems to be in good condition.

b. Adequacy of Information

Information relating to the design and construction of the dam is lacking. The conclusions presented in this report are based upon field measurement, past performance and present condition of the dam. Information on the design hydrology, hydraulic design, and the operation and maintenance of the dam were not available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency

The steepness (almost vertical) of the scarps observed on the downstream slope, in conjunction with the seepage observed at the base of the scarps, poses a potential instability of the embankment, which should be investigated in the immediate future. The remaining remedial measures recommended in Section 7.2 should be accomplished within a reasonable period of time.

d. Necessity for Phase II Inspection

Based on results of the Phase I inspection, a Phase II inspection is not felt to be necessary. However, the remedial measures described in Paragraph 7.2 should be undertaken within the time frame recommended in Section 7.1(c).

7.2 Remedial Measures

a. Alternatives

There are several general options that may be considered to reduce the possibility of dam failure or to diminish the harmful consequences of such a failure. Some of these options are:

1. Increase spillway capacity to pass the Probable Maximum Flood without overtopping the dam.

2. Increase the height of the dam enough to pass the PMF without overtopping the dam. An investigation should also be done that includes studying the effects on the structural stability of the existing embankment and the spillway. The overtopping depth during the occurrence of the PMF, stated in Section 5.1d, is not the required or recommended increase in the height of the dam.

3. A combination of 1 and 2 above.

b. O & M Procedures

1. Perform an investigation of the stability and safety of the embankment due to the scarps and the seepage observed on the downstream slope.

2. The erosion due to wave action on the upstream slope should be monitored and if the erosion continues, protective measures should be employed to protect the slope from further damage.

3. Remove the trees from the downstream and upstream slopes of the dam. Removal of large trees should be under the guidance of an engineer experienced in the design and construction of earthen dams.

4. Determine the extent of damage done to the embankment by burrowing animals, and corrective repairs made as required. All burrowing animals should be eliminated from the embankment and their burrows properly backfilled and compacted.

5. The vegetation on the embankment should be properly maintained and an adequate vegetative cover retained on the embankment to protect it from surface erosion. A heavy growth of vegetation on the embankment could prevent a comprehensive inspection of the dam and potential problems could go undetected.

6. If during periods of spillage over the roadway at the right end of the dam, the water flows down the right upstream abutment contact area, a permanent berm should be constructed in order to direct this flow to a point beyond the abutment contact area and downstream toe. Once the flow is downstream from the abutment contact area and the toe of the dam, it may be directed towards the downstream channel.

7. The entire spillway should be watched and checked periodically for progressive erosion and sloughing which would be seriously detrimental to its proper functioning. If these things do occur, remedial action should be taken.

8. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

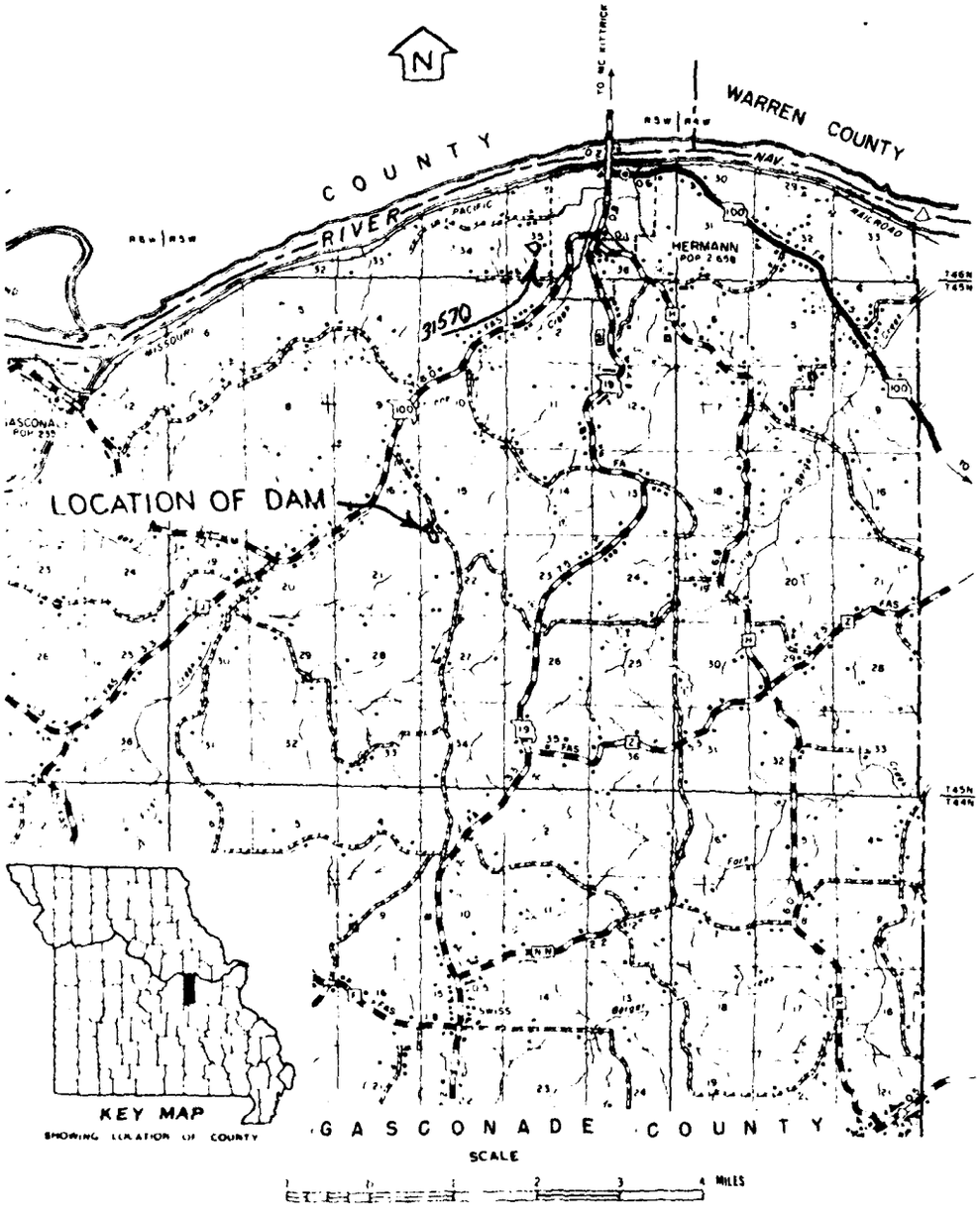
9. The owner should initiate the following programs:

   (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earthen dams.

   (b) Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

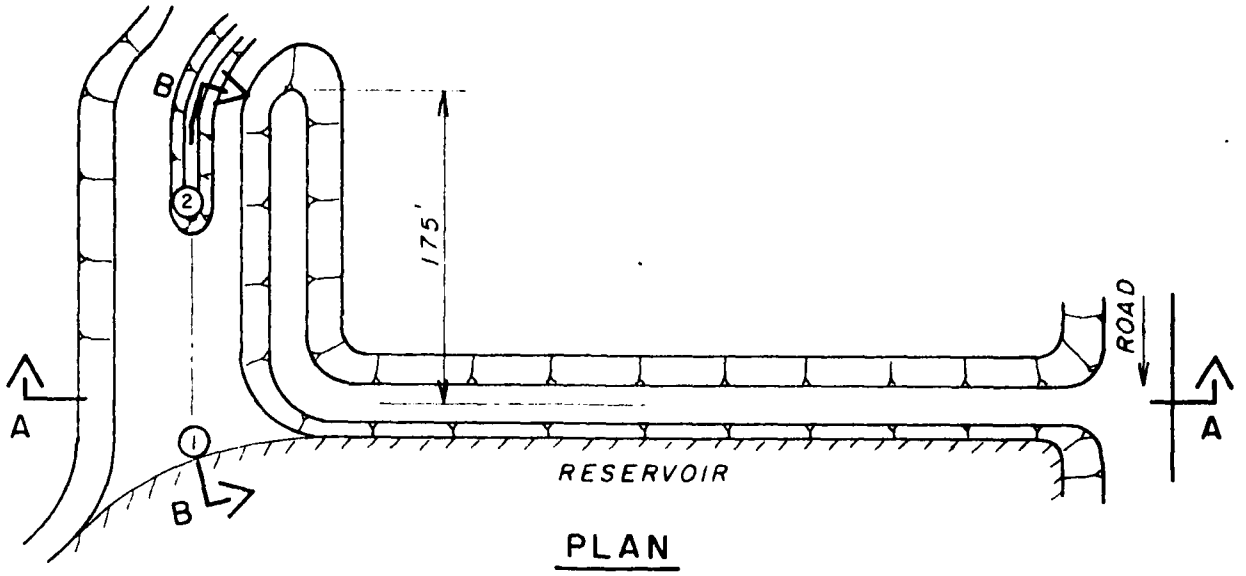
PLATES

PLATE 1

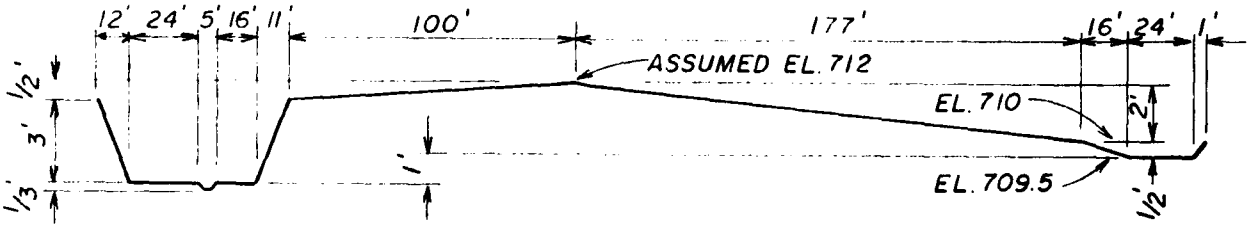


LOCATION MAP – BENSON LAKE DAM
MO. 30667

PLATE 2

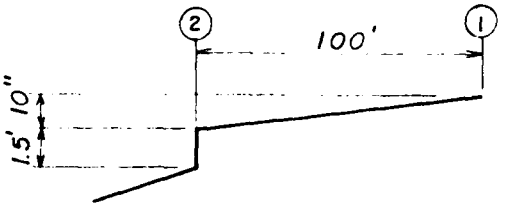


PLAN

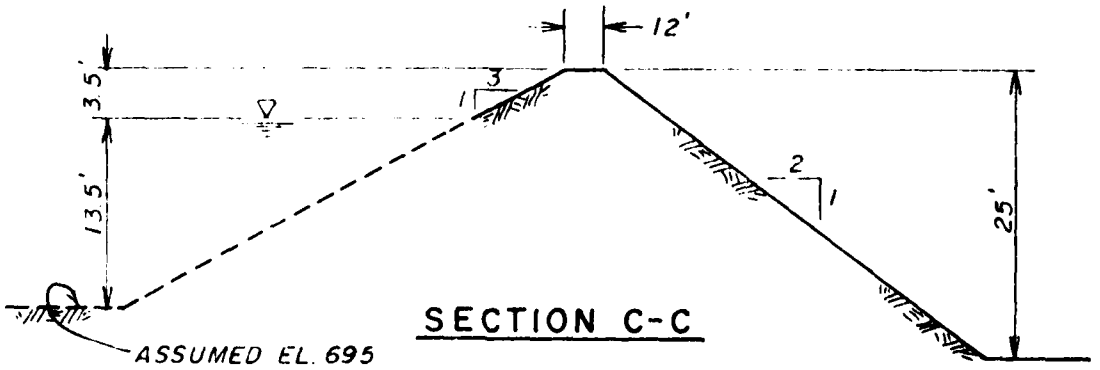


SECTION A-A

SCALE:
1" = 60' HORIZ.
VERT. - NOT TO SCALE



SECTION B-B



SECTION C-C

BENSON LAKE DAM (MO. 30667)
PLAN AND SECTIONS

SCALE

10 0 10 20 30 40 Miles

⊕ LOCATION OF DAM

NOTE: LEGEND OF THIS DAM IS ON PLATE 4

REFERENCE:

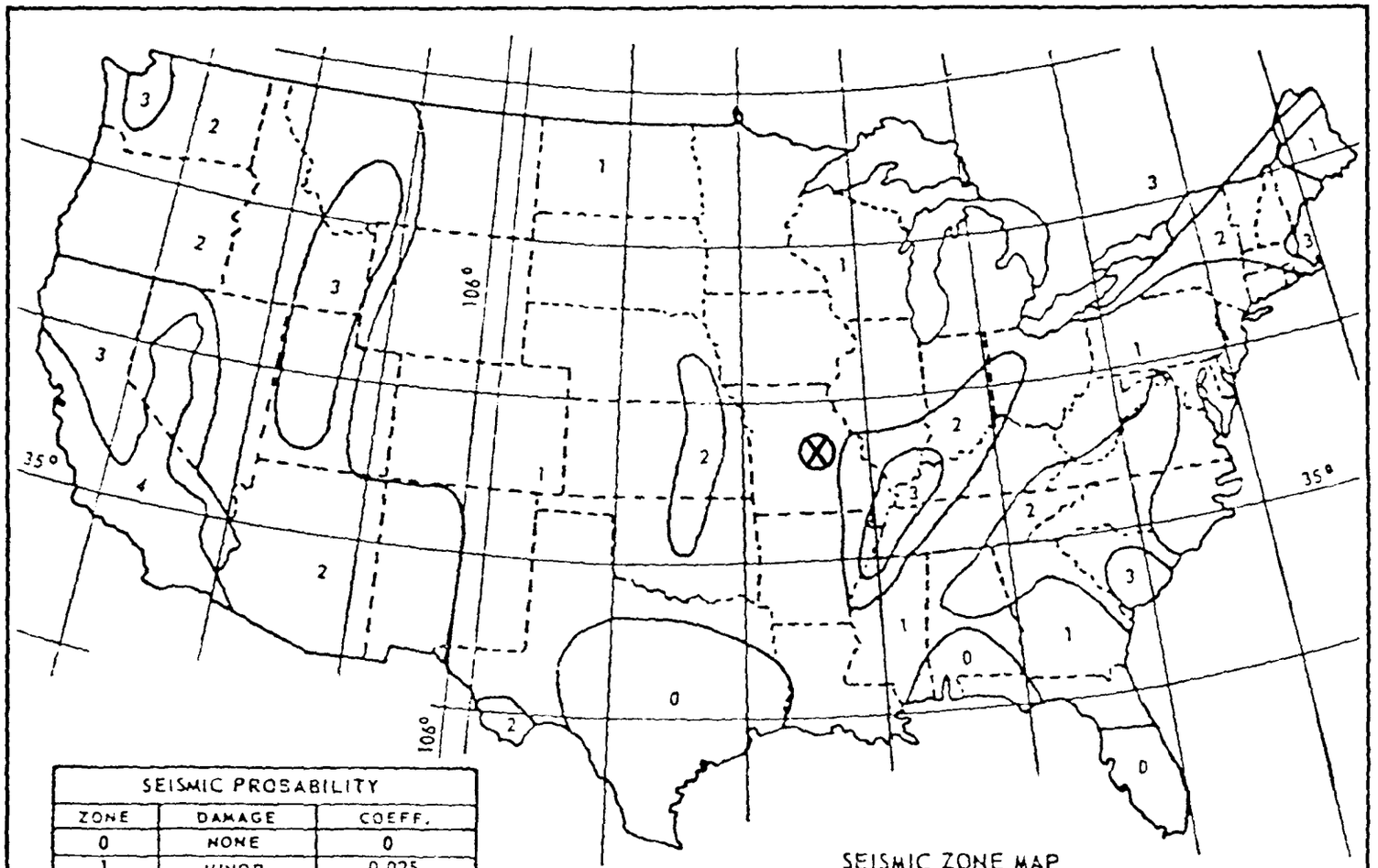
GEOLOGIC MAP OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
MISSOURI GEOLOGICAL SURVEY
KENNETH H. ANDERSON, 1979

REGIONAL GEOLOGICAL MAP OF BENSON LAKE DAM

PLATE 4

LEGEND

PERIOD	SYMBOL	DESCRIPTION
QUATERNARY	Qal	ALLUVIUM: SAND, SILT, GRAVEL
	Pu	PENNSYLVANIAN UNDIFFERENTIATED
PENNSYLVANIAN	Pm	MARMATON GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
	Pcc	CHEROKEE GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
MISSISSIPPIAN	Mm	ST LOUIS FORMATION: LIMESTONE INTERBEDDED WITH SHALE.
		SALEM FORMATION: LIMESTONE INTERBEDDED WITH SHALE AND SILTSTONE
		WARSAW FORMATION: ARGILLACEOUS LIMESTONE AND CALCAREOUS SHALE
	Mo	KEOKUK- BURLINGTON FORMATION: CHERTY GRAYISH BROWN SANDY LIMESTONE
DEVONIAN	D	CHATTANOOGA SHALE, SYLAMORE SANDSTONE
ORDOVICIAN	Omk	MAQUOKETA SHALE, KIMMSWICK LIMESTONE
	Odp	DECORAH FORMATION: GREEN TO GRAY CALCAREOUS SHALE WITH THIN FOSSILIFEROUS LIMESTONE
	Osp	ST. PETER SANDSTONE
	Ojc	SMITHVILLE FORMATION POWELL DOLOMITE



SEISMIC PROBABILITY		
ZONE	DAMAGE	COEFF.
0	NONE	0
1	MINOR	0.025
2	MODERATE	0.05
3	MAJOR	0.10
4	GREAT	0.15

⊗ APPROXIMATE LOCATION OF BENSON LAKE DAM

SEISMIC ZONE MAP
of
CONTIGUOUS STATES

PLATE 5

APPENDIX A

PHOTOGRAPHS

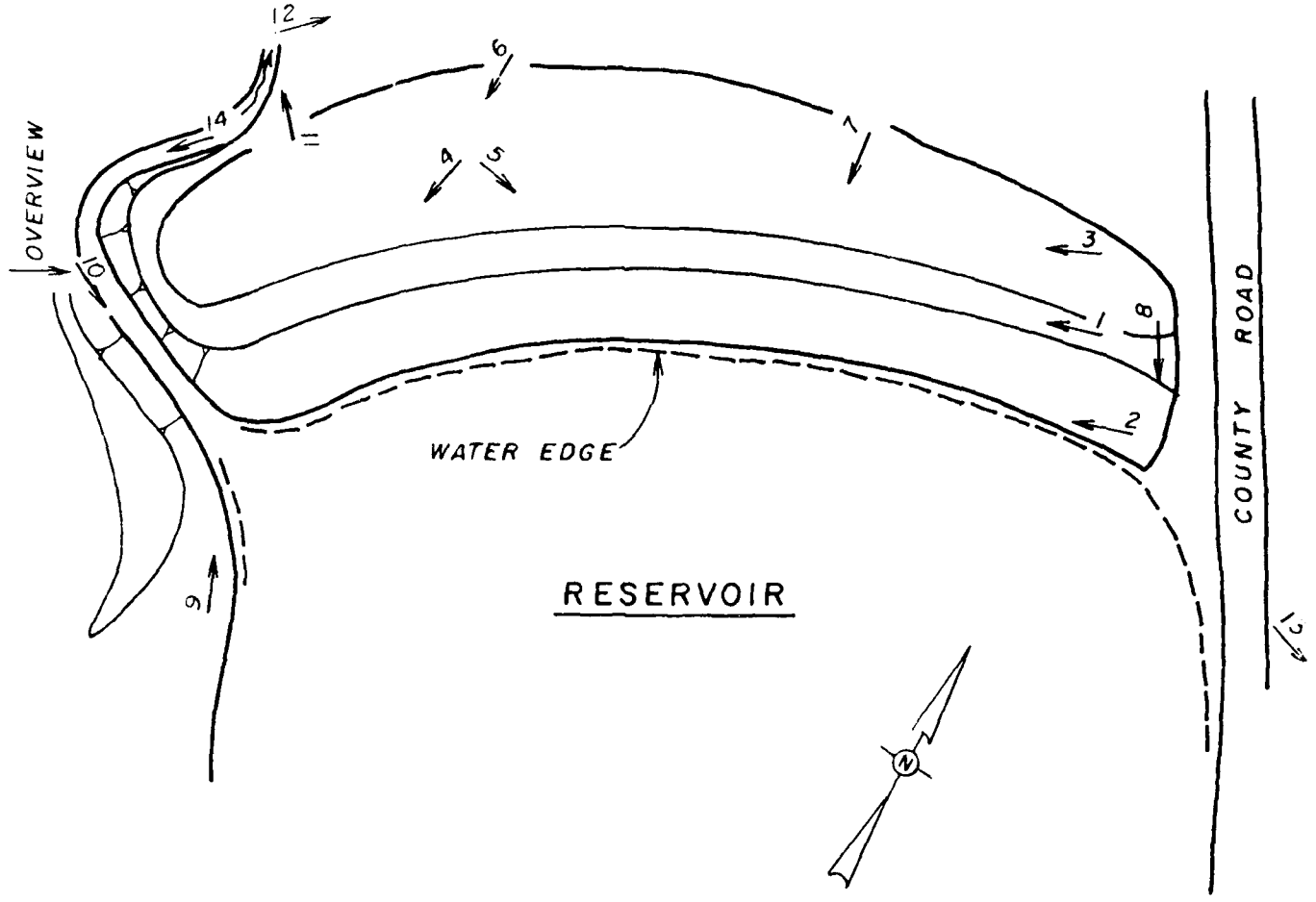


PHOTO INDEX
FOR
BENSON LAKE DAM

Benson Lake Dam

Photographs

Photo 1 - Top of dam showing tall grass protection.

Photo 2 - Upstream slope of dam showing dense grass protection with a tree and some small brush growing.

Photo 3 - Downstream slope of dam showing dense grass protection adjacent to slope supporting trees and brush.

Photo 4 - View of sloughed area on downstream slope of dam, supporting growth of cattail reeds; indicated continuous moisture condition.

Photo 5 - View of sloughed area adjacent to area in photo 4.

Photo 6 - View of very wet ground just below sloughed areas of photos 4 and 5.

Photo 7 - View of hole indicating possible burrowing activity on downstream slope area.

Photo 8 - Reservoir rim area showing adjacent road and mild grassy and tree-lined slopes.

Photo 9 - Inlet to principal spillway showing small amount of rock slope protection.

Photo 10 - Principal spillway channel showing brush, fence, sloughing, erosion, and dense grass growth.

Photo 11 - Downstream channel area showing tree-lined banks and structure.

Photo 12 - Structures in area downstream of dam.

Photo 13 - Geology--Ordivician dolomite, horizontal, interbedded with brown, calcareous sandstone.

Photo 14 - Geology--Ordovician brown to light grey shale, interbedded with calcareous sandstone.

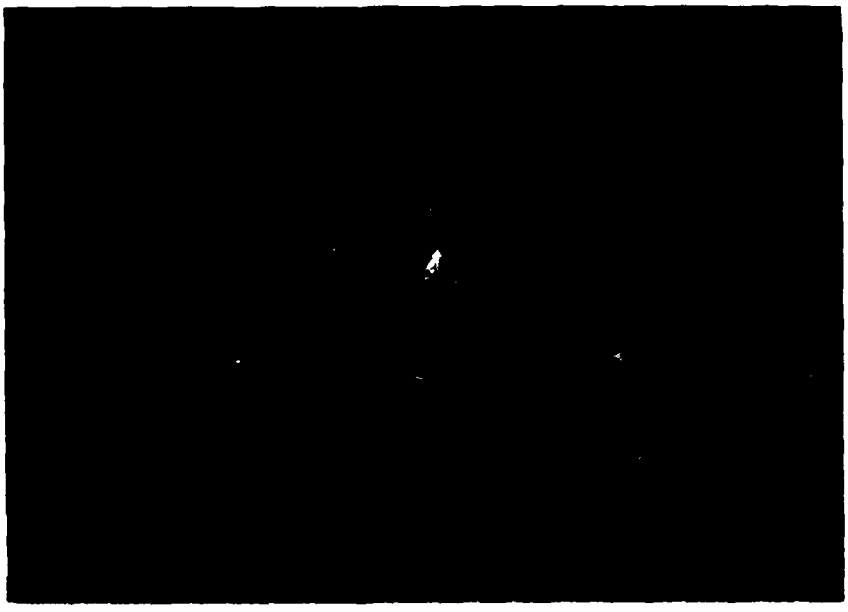


Photo 1

Photo 2

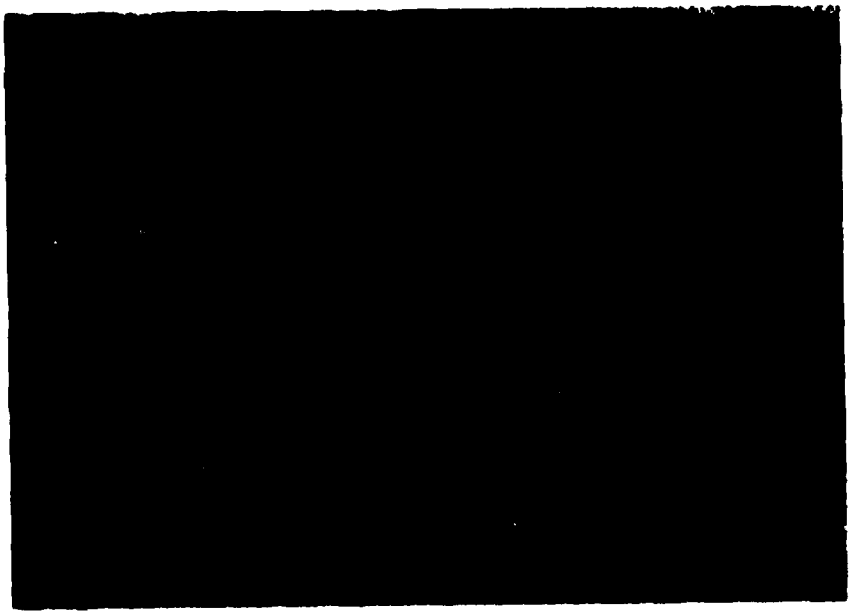


Photo 3

Photo 4

Photo 5

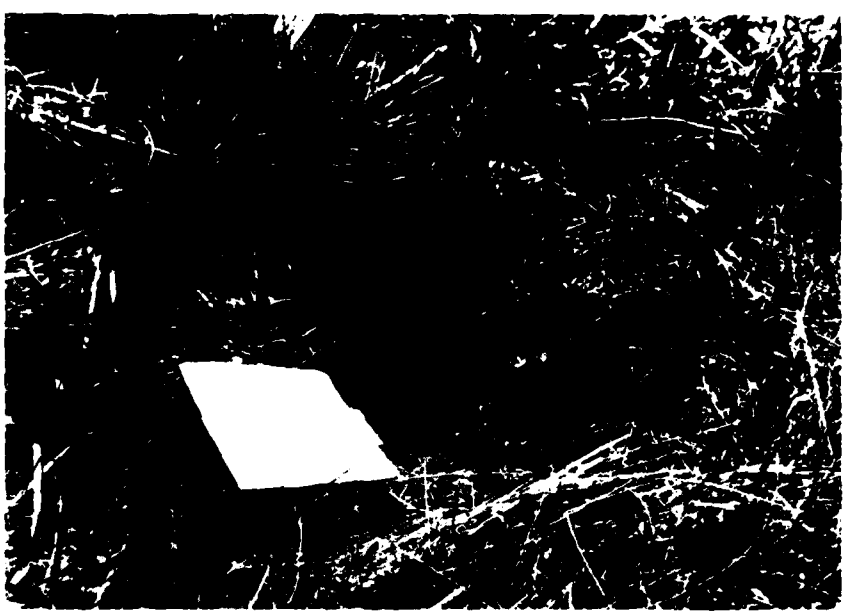


Photo 6

Photo 7

Photo 8

Photo 9

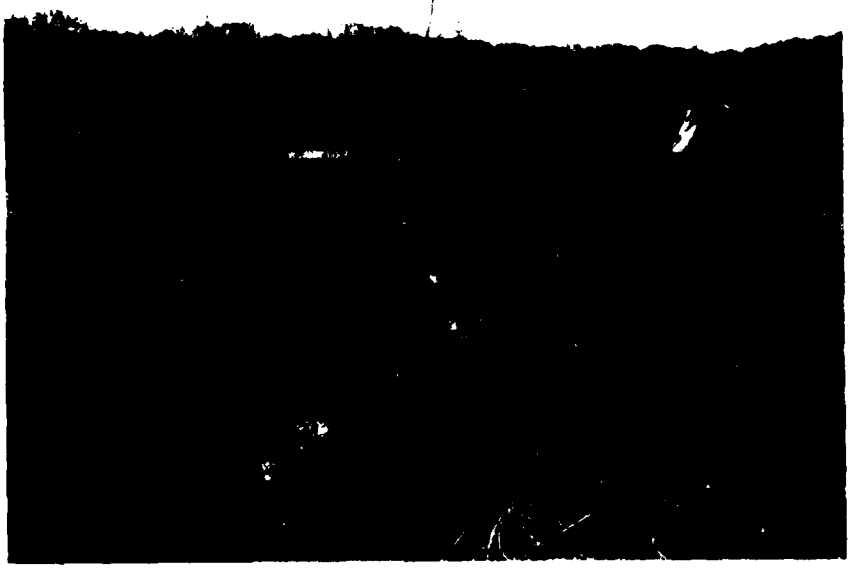


Photo 10

Photo 11

Photo 12

Photo 13

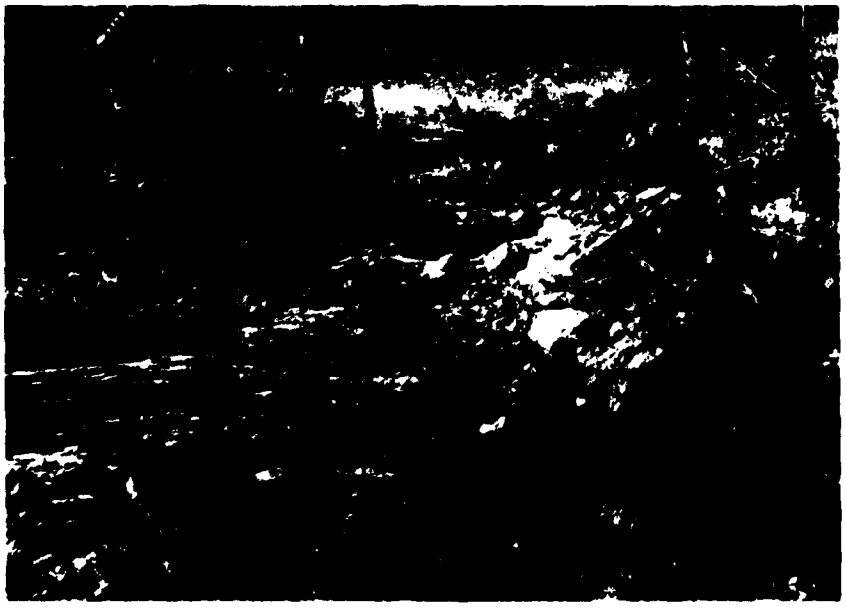
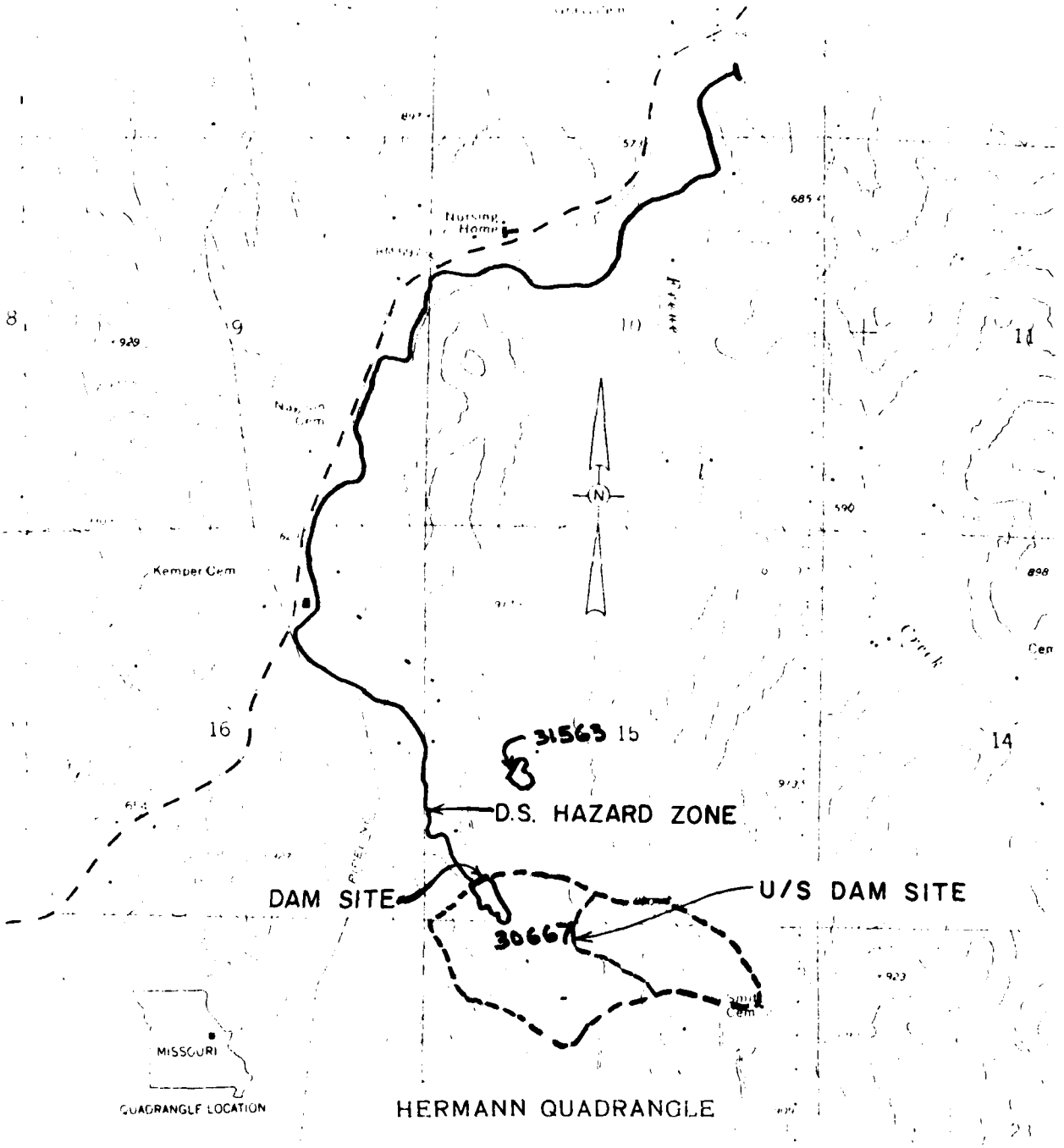


Photo 14

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

PLATE 1, APPENDIX B



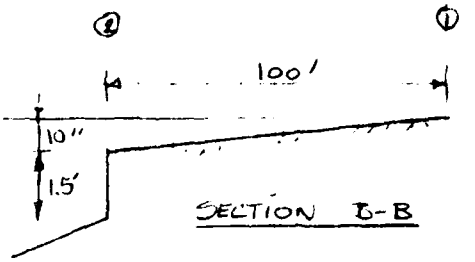
BENSON LAKE DAM MO 30667

DRAINAGE BASIN

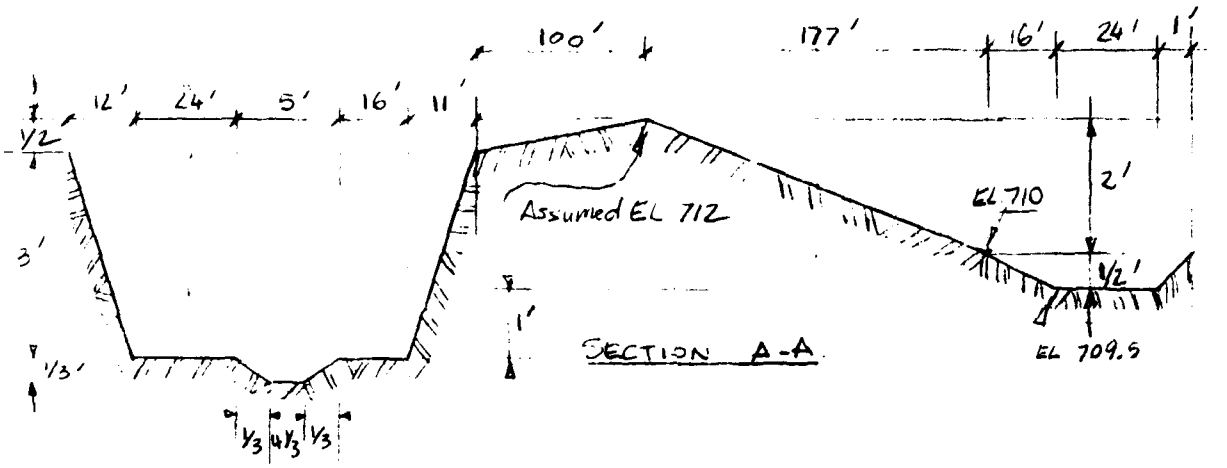
B-2

PRC ENGINEERING CONSULTANTS, INC.

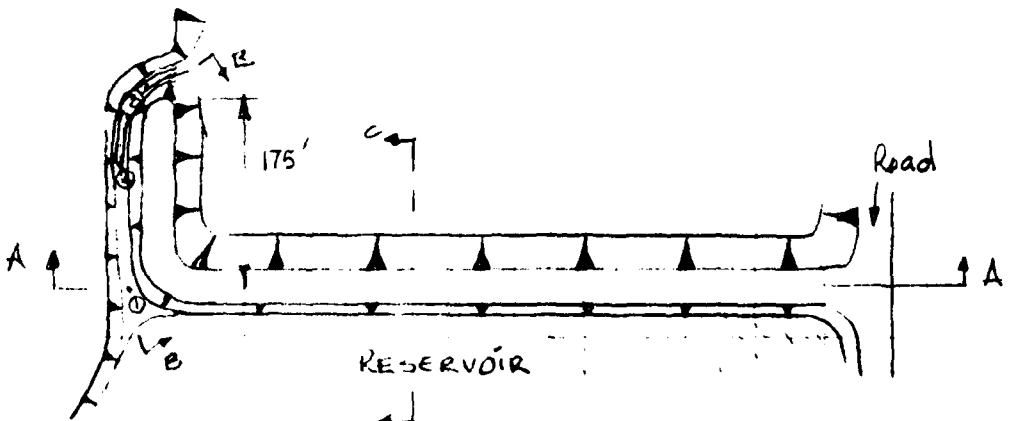
DAM SAFETY INSPECTION / MISSOURI — SHEET NO. 1 OF 5
BENSON LAKE DAM #30667 — JOB NO. 1263
SPILLWAY & OUTLET RATING CURVE — BY FZ DATE MAY 80

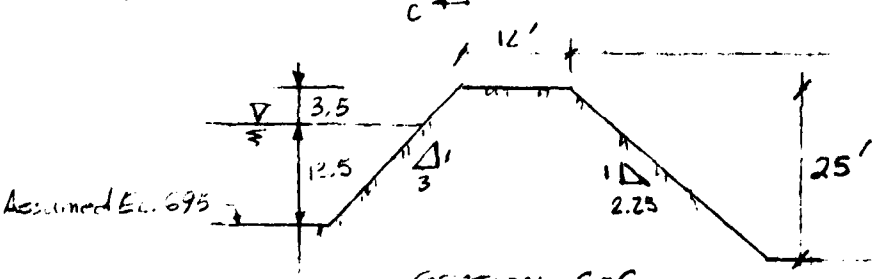


SECTION B-B



SECTION A-A





SECTION C-C

B-3

PRC ENGINEERING CONSULTANTS, INC.

SHEET NO. 2 OF 5

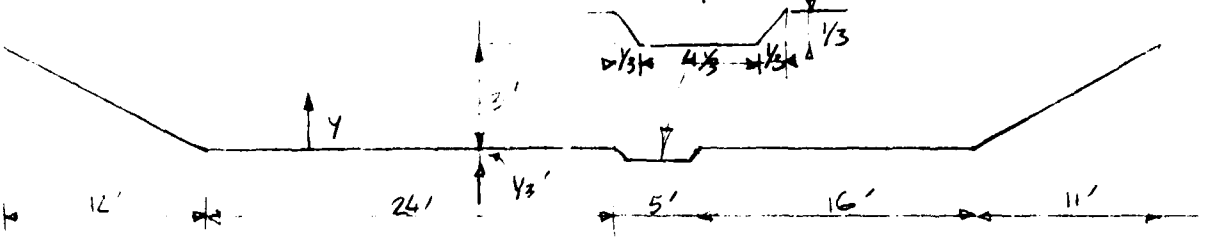
JOB NO 1263

BY FZ DATE MAY 80

Spillway channel

$P = \frac{13+2\bar{1}2}{3} = 5.3$ ft

$A = \frac{14}{9}$ sqft $= 1.6$ sqft



Slope of channel $= \frac{10}{1200} = 0.0083$

$n = 0.03$ assumed

$Y \leq 3$ $A = Y(3.83Y + 45) + 1.6$

$P = 45.3 + 7.42h$

$\frac{1.49 \times S^{1/2}}{n} = \frac{1.49 \times \sqrt{0.0083}}{0.03} = 4.53$

$Q = 4.53 \frac{A^{5/3}}{P^{2/3}}$ $T = 45 + 7.67Y$

$Y > 3$ $A = 68Y - 33$ $P = 69$ $\frac{1.49 \times S^{1/2}}{n \times P^{2/3}} = 0.27$ $Q = 0.27\, A^{5/3}$ $T = 68$

$Q_c = \sqrt{\frac{A^3 g}{T}}$

Y_c	Q_c	Y_{Normal} for $Q = Q_c$	Remark
1'	280	1.16'	Subcritical
2'	803	2.17'	"
3'	1540	3.10'	"
4'	2343	4.05'	"
5'	3102	4.95'	Supercritical

PRC ENGINEERING CONSULTANTS, INC.

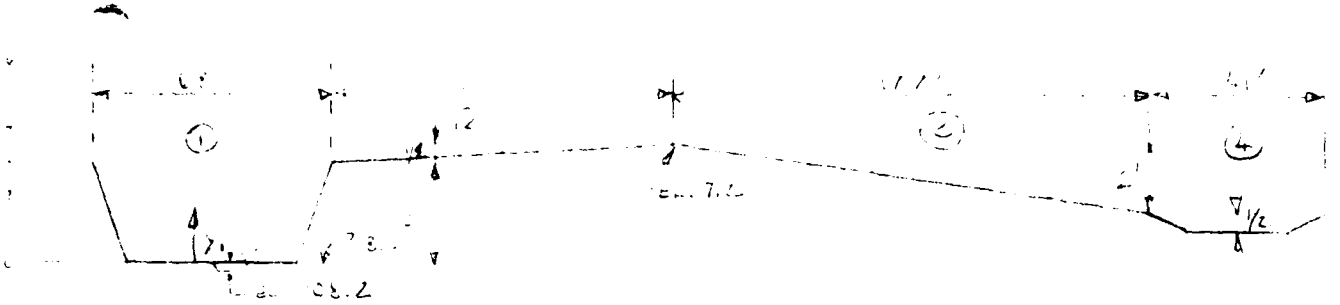
DAM SAFETY INSP. / EVALUATION — SHEET NO 3 OF 5
JENSEN LAKE DAM #30667 — JOB NO 1263
SPILLWAY CAPACITY VS. CURVE — BY FZ DATE MAY 80

Length required to go from critical depth to normal depth.

$$\Delta L = \frac{Y_N - Y_c + \frac{V_N^2}{2g} - \frac{V_c^2}{2g}}{0.0082 - n^2/1.5 A_m R_m^{4/3}} \quad \frac{N}{D}, \quad A_m R_m^{4/3} = \frac{A_m^{5/3}}{P_m^{2/3}}$$

Y_c	I_m	A_c	A_N	$V_c^2/2g$	$V_N^2/2g$	A_m	P_m	φ	N	D	ΔL
1	1.16	50.43	58.45	1.474	0.35	54.70	53.85	280	0.031	0.002	16'
2	2.17	106.44	117.31	0.887	0.737	112.13	61.81	808	0.020	0.0011	18.'
3	2.10	171.12	172.45	1.258	1.143	171.54	69.46	1540	0.005	0.0008	6'

Conclusion the normal depth regime will be reached in a short distance and normal depth is to be considered for depth below 5'



$H_2 = H_1 - 2$

$d_{c_2} = \frac{1}{2}(H_2 + \frac{1}{4} \times \frac{1}{2}) = \frac{8H_2 - 1}{12}$

$A_2 = \frac{1}{2} T_2 (4 d_{c_2} - \frac{1}{2}) = 25(4 d_{c_2} - 1)$

$Q_2 = \sqrt{\frac{A_2^3 g}{T_2}} = 0.57 A_2^{3/2}$

③ $d_{c_3} \leq 2 \Rightarrow d_{c_3} = \frac{1}{2} H_3$, $T_3 = \frac{177 d_{c_3}}{2}$ } $A_3 = \frac{177 d_{c_3}^2}{4}$

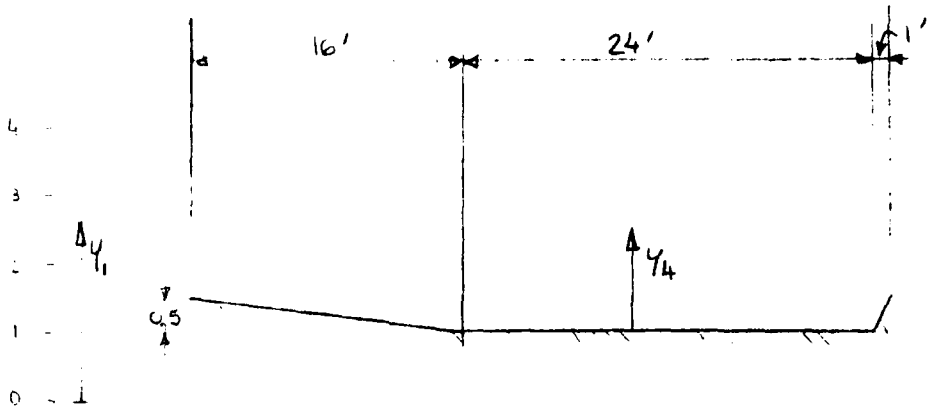
$d_{c_3} > 2 \quad d_{c_3} = (2H_3 + 1)\frac{1}{2}$, $T_3 = 177$ } $A_3 = 177(d_{c_3} - 1)$

$Q_3 = \sqrt{\frac{A_3^3 g}{T_3}}$

B-6

Spillway ①							②				③				
Y_1	A_1	T_1	T_1	Q_1	$(\frac{Q}{A_1})^2/g$	H_1	$H_2 = H_1 - 3$	d_{c_2}	A_2	Q_2	$H_3 = H_1 - 1.5$	d_{c_3}	T_3	A_3	Q_3
1	50.4	53.2	—	220	0.30	1.30	—	—	—	—					
2	106.9	61.1	—	702	0.67	2.67	—	—	—	—	1.17	0.14	82.8	38.8	150
3	171.1	69.1	—	1418	1.07	4.07	1.07	0.80	54.7	229	2.57	2.05	177	185.3	1076
4	239.0	69.1	—	2473	1.66	5.66	2.66	1.86	160.7	1156	4.16	3.11	177	372.9	3071
5	307.0	—	68	3702	2.16	7.20	4.26	2.92	267.3	2480	5.76	4.17	177	561.7	5678
6	375.1	—	68	4997	2.76	8.76	5.16	3.92	367.3	3995	7.26	5.17	177	738.7	8563

(4)



Assumed critical depth

$A_4 = 41Y_4 - 4.25$ $\quad T_4 = 41'$ $\quad V_4 = \sqrt{\frac{A_4 g}{T_4}}$ $\quad Q_4 = A_4 V_4$ $\quad \frac{V_4^2}{2g} = \frac{A_4}{2T_4}$

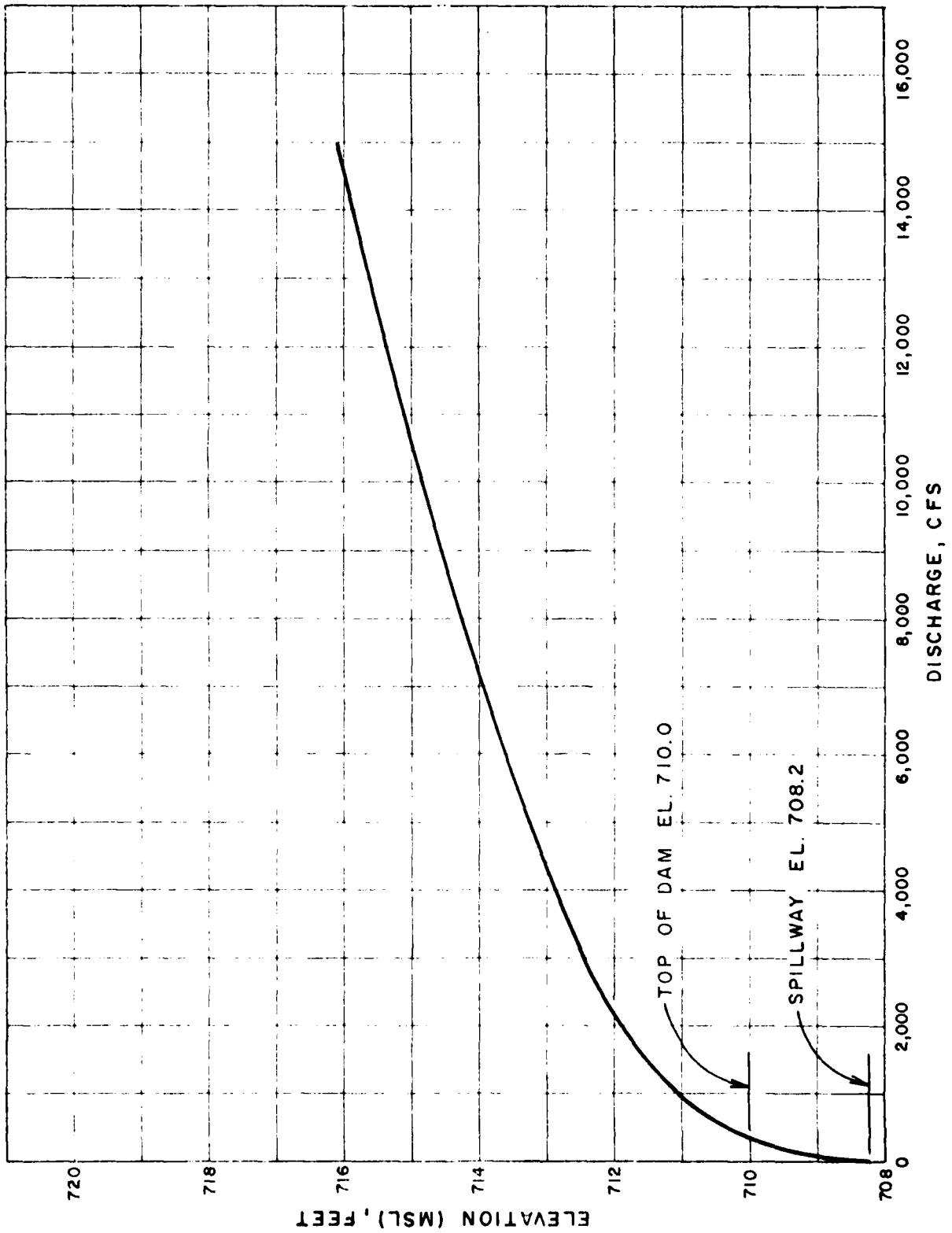
$H_4 = Y_4 + \frac{V_4^2}{2g}$

For 1st iteration we have to find Q_4 for $H_4 + 1 = H_1$ (pg. 10)

WSEL = 708.5 + H_1

	H_1	Y_4	A_4	$\frac{V_4^2}{2g}$	H_4	Q_4	$Q_1+Q_2+Q_3+Q_4$	WSEL
1	1.3	0.258	5.73	0.092	0.30	14	233	709.80
2	2.67	1.148	42.02	0.522	1.67	248	1100	711.17
3	4.07	2.081	81.07	0.989	3.07	647	3370	712.57
4	5.66	3.142	124.57	1.511	4.66	1232	7932	714.16
5	7.76	4.208	168.28	2.052	6.26	1934	13 794	715.76
6	9.26	5.208	209.28	2.552	7.76	2683	20 238	717.26

$y = 0.5$ $\quad A = y(17y + 24)$
$T = 34y + 24$



BENSON LAKE DAM (MO. 30667)
SPILLWAY & OVERTOP RATING CURVE

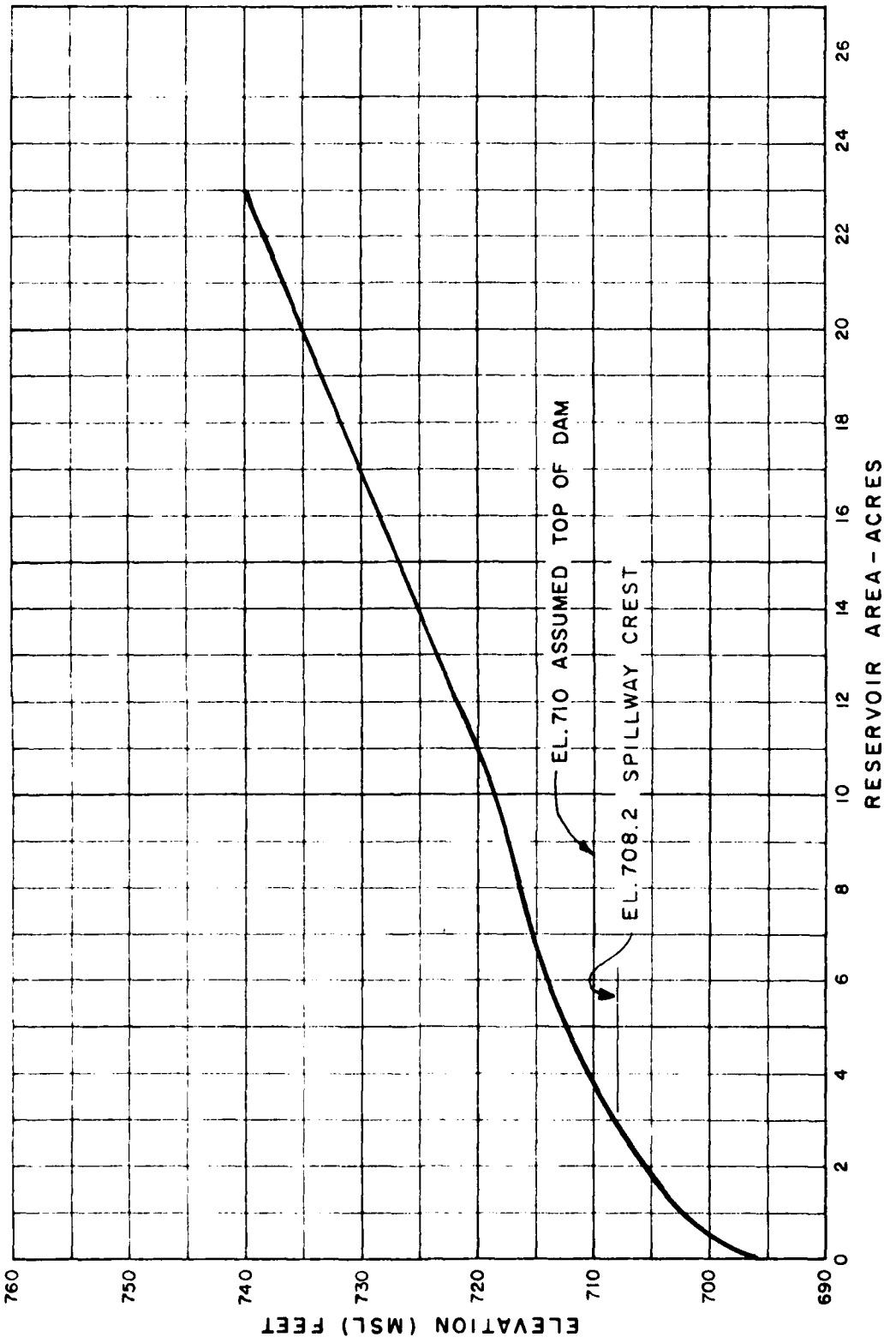
PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI SHEET NO. 1 OF 1

DAM NAME: BERGER LAKE DAM ID NO.: 30661 JOB NO. 1263

RESERVOIR ELEVATION AREA DATA BY FE DATE MAY 80

ELEV. (M.S.L.) (Ft.)	RESERVOIR SURFACE AREA (Acres)	REMARKS
[illegible]	0	Assumed bottom of lake
[illegible]	0.2	Interpolated.
703.	3	- Assumed Spillway Crest
704.5	4	- Roadway acting as emergency spillway
712	5	- High point of dam
720	11	- Measured on USGS QUAD.
730	17	- Interpolated.
[illegible]	22	Measured on USGS QUAD



BENSON LAKE DAM (MO. 30667)
RESERVOIR ELEVATION - AREA CURVE

PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. 1 OF 1
DAM NAME: BENTON LAKE DAM # 30667 — JOB NO. 1263
UNIT HYDROGRAPH PARAMETERS — BY FZ DATE 5/22/80

1) DRAINAGE AREA, A = 0.145 sq. mi = (92.5 acres)

2) LENGTH OF STREAM, L = (0.95 " × 2000' = 1900 ') = 0.36 mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

H_1 = 810'

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, H_2 = 711.2

5) ELEVATION OF CHANNEL BED AT 0.85L, E_{85} = 780

6) ELEVATION OF CHANNEL BED AT 0.10L, E_{10} = 715

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10}) / 0.75L = \frac{780-715}{0.75 \times 1900} = 0.046$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$t_c = [(11.9 \times L^3)/(H_1 - H_2)]^{0.385} = \left(\frac{11.9 \times 0.36^3}{810 - 711.2}\right)^{0.385} = 0.136$ hr.

B) BY VELOCITY ESTIMATE,

SLOPE = 5% ⇒ AVG. VELOCITY = 4 fps.

$t_c = L/V = \frac{1900}{4} \times \frac{1}{3600} = 0.132$ hr

USE t_c = 0.136 hr

9) LAG TIME, $t_l = 0.6\, t_c = 0.6 \times 0.136 = 0.082$

10) UNIT DURATION, $D \leq t_l / 3 = \frac{0.082}{3} = 0.027$ < 0.083 hr.

USE D = 0.083 hr

11) TIME TO PEAK, $T_p = D/2 + t_l = \frac{0.083}{2} + 0.082 = 0.123$ hr

12) PEAK DISCHARGE,

$q_p = (484 \times A) / T_p = \frac{484 \times 0.145}{0.123} = 570$ cfs

DETERMINATION OF PMP

1) Determine drainage area of the basin

D.A. = 92.5 Ac

2) Determine PMP Index Rainfall (for D.A. = 200 sq. mi. & 24 hr. duration)

Location of centroid of basin,

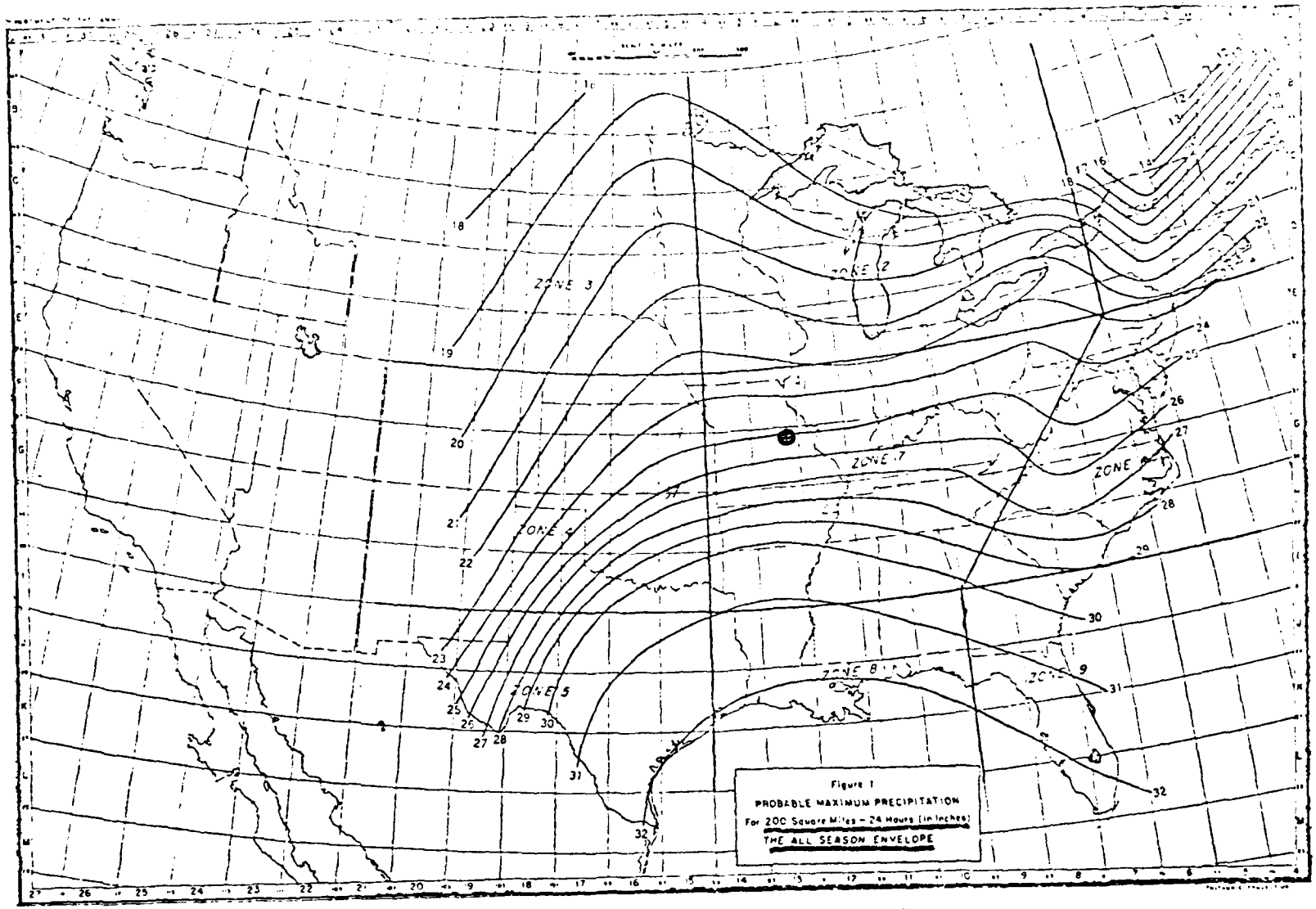
Long. = 11° 28' 19" Lat. = 38° 38' 35"

PMP = 25.2 (from Fig. 1, HMR 33)

Zone = 7

3) Determine basin rainfall in terms of percentage of PMP Index Rainfall for various durations. (from Fig. 2, HMR 33)

Duration (Hrs.)	Percent of Index Rainfall (%)	Total Rainfall (Inches)	Rainfall Increments (Inches)	Duration of Increment (Hrs.)
6	100	25.2	25.2	6
12	120	30.2	5	6
24	130	32.8	2.6	12



● LOCATION OF CENTROID OF BASIN

BENSON LAKE DAM
DETERMINATION OF PMF

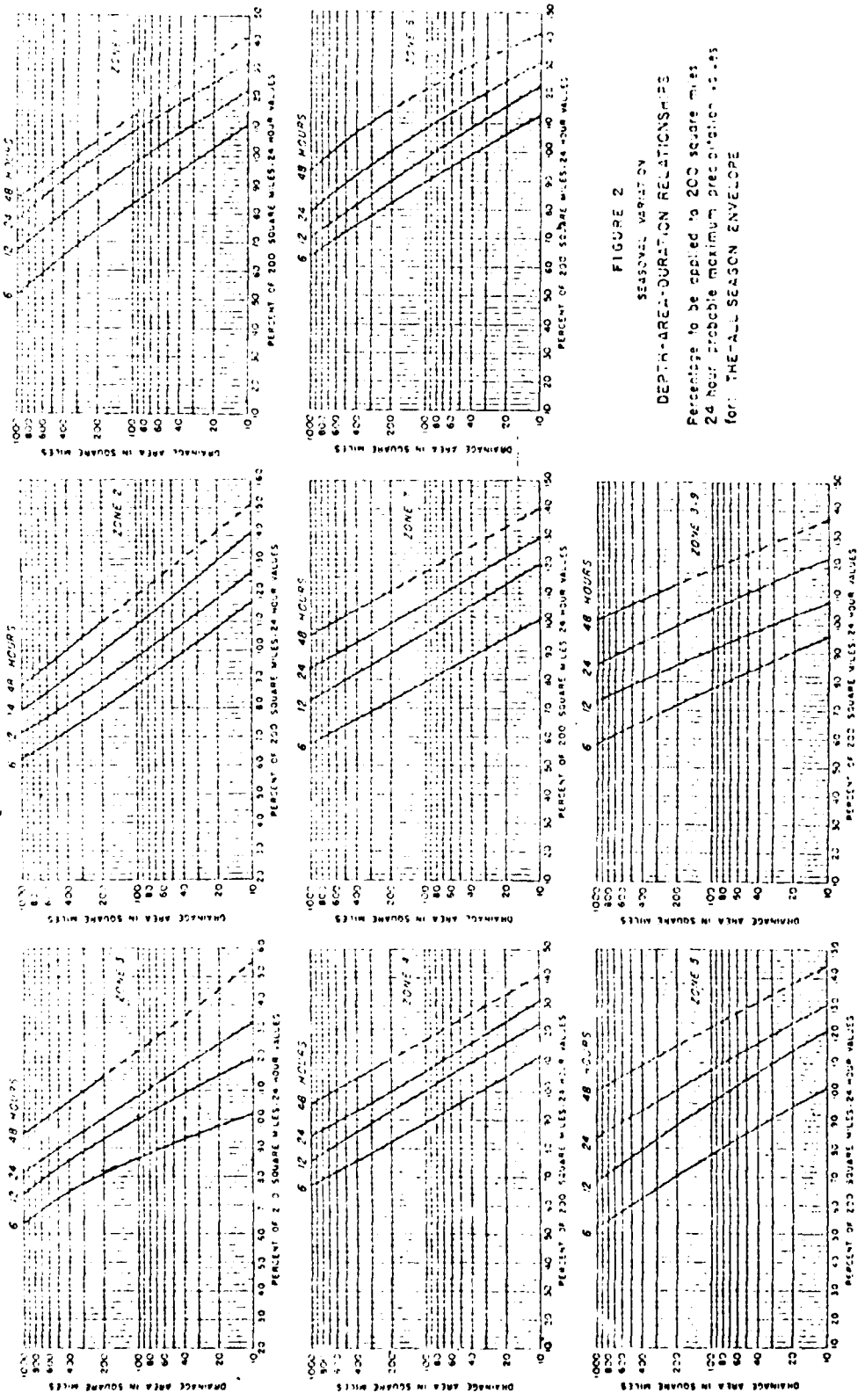


FIGURE 2

SEASONAL VARIATION

DEPTH-AREA-DURATION RELATIONSHIPS

Percentage to be applied to 200 square mile 24 hour probable maximum precipitation values for THE ALL SEASON ENVELOPE

PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI - 1980 SHEET NO. 1 OF 1

DAM NAME: PEARSON LAKE DAM #30667 JOB NO. 1263

CURVE NUMBER DETERMINATION (UPSTREAM PEARSON LAKE DAM) BY [illegible] DATE [illegible]

I) SOIL GROUP

WATERSHED SOILS IN THE BASIN CONSIST OF GROUP A. (B.) C. D

GROUP B SOILS SEEM TO PREDOMINATE THE BASIN. THEREFORE, ASSUME GROUP B SOILS FOR THE ENTIRE WATERSHED FOR HYDROLOGIC PURPOSES.

II) COVER COMPLEX

ASSUMED LAND USE	ASSUMED HYDROLOGIC CONDITION	PER CENT AREA	CN (AMC II)
FOREST	FAIR	70%	60
RANGE	FAIR	30%	69

III) CURVE NUMBER

WEIGHTED AVERAGE CN = 63 FOR AMC II

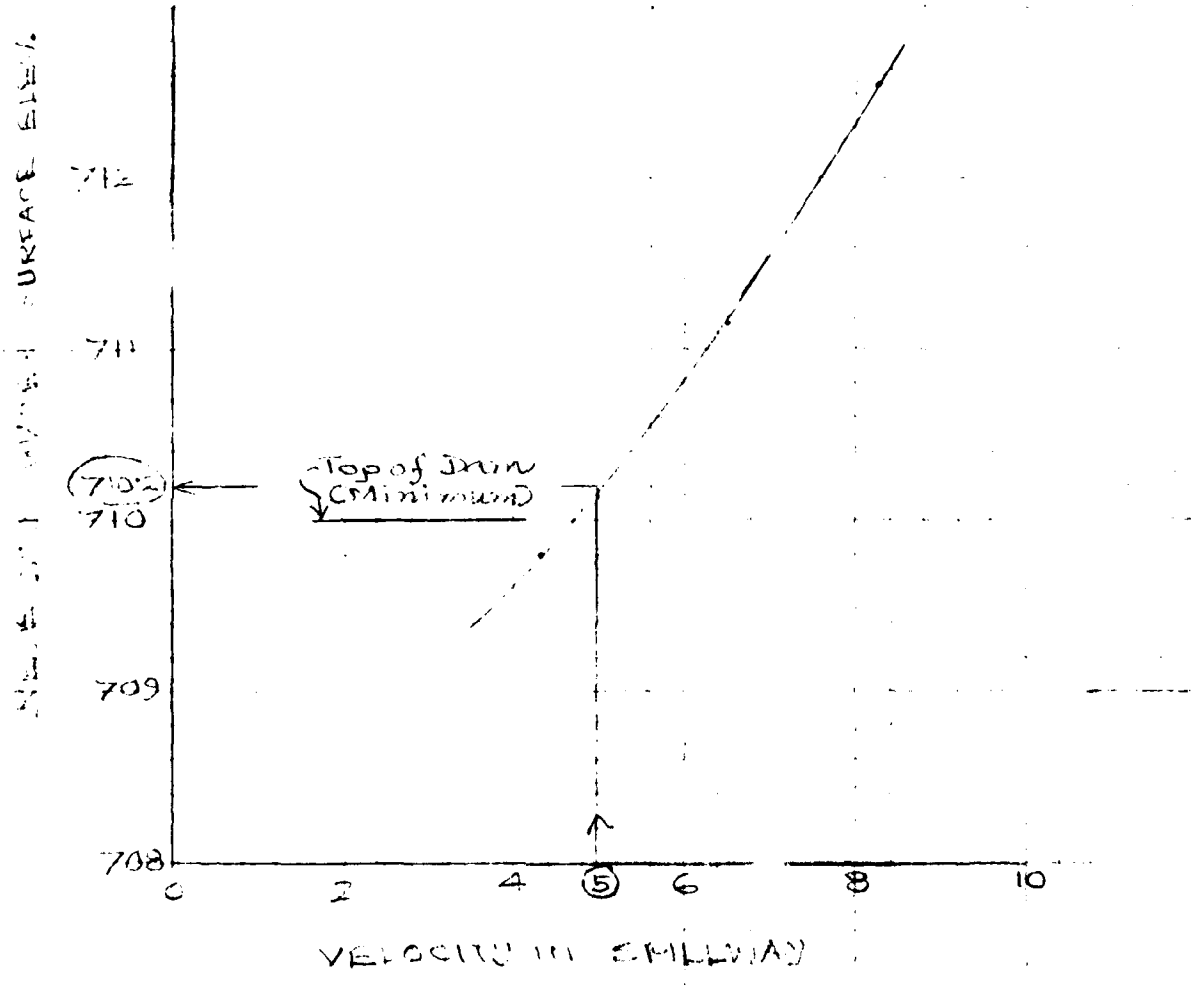
CURVE NUMBER = 80 FOR AMC III

PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. 1 OF 1

[illegible] — JOB NO. 1265

DETERMINATION OF EFFECTIVE TOP OF DAM — BY MAS DATE 6-9-80



Assuming a 5 ft/sec permissible velocity (Kentucky Blue Grass - Sandy Silt) the effective top of dam is found to be 710.2 ft above MSL which is higher than minimum top of dam elevation. Use the minimum top of dam elev. for overtopping analysis.

HEC1DB INPUT DATA

```
**************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  26 FEB 79
**************************************
  1         A1                    DAM SAFETY INSPECTION - MISSOURI
  2         A2                       BENSON LAKE DAM (MO 30667)
  3         A3      PMF AND HALF PMF WITH U/S DAM BREAK IN CASE OF DAM OVERTOP
  4         B     300        0        5        0        0        0        0        0        0        0
  5         B1      5
  6         J       1        2        1
  7         J1      1       .5
  8         K       0 U/S DAM                                           1
  9         K1   RUNOFF CALCULATION FOR U/S DAM DRAINAGE AREA
 10         M       1        2     .365              .365        1                          1
 11         P             25.2      100      120      130
 12         T                                                          -1      -.07
 13         W2           .244
 14         X                       1
 15         K       1 U/S DAM                                           1
 16         K1      ROUTE HYDROGRAPH THROUGH U/S DAM
 17         Y                                1        1
 18         Y1      1                                                -742        -1
 19         Y4    742      743   744.36    745.2   745.75    746.5   747.28   748.78   750.28
 20         Y5      0       20      100      170      330      750     1361     3424     6100
 21         $A      0        1        2      4.5        6        7
 22         $E    730      743      747      760      770      780
 23         $$    742
```

```
                                                                              1
K1     CHANNEL ROUTING
Y                                      1        1
Y1     1
Y6   .05      .05     .05     720      740     1000     .025
Y7            740     40      730      90      723      95      720     105     720
Y7   110      723     100     730      250     740
K              30557                                     1
K1   RUNOFF CALCULATION FOR BENSON LAKE DAM RUNOFF AREA
      1        2      .145             .145      1                      1
P             25.0    110     120      130
T                                                       -1      -.1
               .042
                               1
K      2    30557                                        1
K1     COMBINE RUNOFF AND UPSTREAM DAM HYDROGRAPH
K      1    30557                                        1
K1     ROUTE HYDROGRAPH THROUGH BENSON LAKE DAM
Y                                      1        1
Y1                                                 -708.2          -1
Y4   708.2    709.5   711.17   710   712.57   714.16   715.76   717.26
Y5            333     600     1100    2200     3370     7932    13794   20238
$A                    3       4       5        11       17       22
$E    705     710     708.2   709.5   712      720      730      740
$$  708.2
```

```
$D    711
K      99
```

INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 75 DAM
ROUTE HYDROGRAPH TO [illegible]
ROUTE HYDROGRAPH TO [illegible]/S
RUNOFF HYDROGRAPH AT [illegible]0567
COMBINE HYDROGRAPH AT [illegible]
ROUTE HYDROGRAPH TO 30667
END OF NETWORK

```
*********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
 LAST MODIFICATION  26 FEB 79
*********************************

RUN  DATE* 07/26/0?.
     TIME* ??.06.??.

                         DAM SAFETY INSPECTION - MISSOURI
                          FENSON LAKE DAM (MO ?1??7)
           ONE AND HALF PMF WITH U/S DAM PEAK IN CASE OF DAM OVERTOP

                              JOB SPECIFICATION
   NQ     NHR     NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
  200       0        5       0       0       0       0       0       0       0
                          JOPER     NWT   LROPT   TRACE
                              5       0       0       0

                     MULTI-PLAN ANALYSES TO BE PERFORMED
                       NPLAN= 1 NRTIO= 2 LRTIO= 1
      RTIOS=   1.50    .50

**********        **********        **********        **********        **********

                        SUB-AREA RUNOFF COMPUTATION

    RUNOFF CALCULATION FOR U/S DAM DRAINAGE AREA

              ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
              US DAM      0       0       0       0       0       1       0       0

                             HYDROGRAPH DATA
    IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
        1      2     .09    0.00     .09    1.00   0.000       0       1       0

                              PRECIP DATA
             SPFE     PMS      R6     R12     R24     R48     R72     R96
             0.00   25.20  100.00  120.00  130.00    0.00    0.00    0.00

                                LOSS DATA
 LROPT  STRKR  DLTKR  RTIOL  ERAIN  STRKS  RTIOK  STRTL  CNSTL  ALSMX  RTIMP
     0   0.00   0.00   1.00   0.00   0.00   1.00  -1.00 -80.00   0.00   0.00

    CURVE NO = -80.00  WETNESS =  -1.00  EFFECT CN =  80.00

                           UNIT HYDROGRAPH DATA
                       TC=  0.00     LAG=   .09

                             RECESSION DATA
                STRTQ=   0.00   QRCSN=   0.00   RTIOR= 1.00

    TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

    UNIT HYDROGRAPH  / END OF PERIOD ORDINATES, TC=   0.00 HOURS, LAG=   .09  VOL= 1.00
```

B-22

250. 275. [illegible] 36. 12. 4. 2.

2

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	0.	1.01	12.35	151	.21	.20	.01	128.
1.01	.10	2	.01	.00	.01	0.	1.01	12.40	152	.21	.20	.01	126.
1.01	.15	3	.01	.00	.01	0.	1.01	12.45	153	.21	.20	.01	125.
1.01	.20	4	.01	.00	.01	0.	1.01	12.50	154	.21	.20	.01	129.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.55	155	.21	.20	.01	130.
1.01	.30	6	.01	0.00	.01	0.	1.01	13.00	156	.21	.20	.01	130.
1.01	.35	7	.01	0.00	.01	0.	1.01	13.05	157	.25	.24	.01	139.
1.01	.40	8	.01	0.00	.01	0.	1.01	13.10	158	.25	.24	.01	151.
1.01	.45	9	.01	0.00	.01	0.	1.01	13.15	159	.25	.24	.01	155.
1.01	.50	10	.01	0.00	.01	0.	1.01	13.20	160	.25	.24	.01	157.
1.01	.55	11	.01	.00	.01	0.	1.01	13.25	161	.25	.24	.01	158.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.30	162	.25	.24	.01	158.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.35	163	.25	.24	.01	159.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.40	164	.25	.24	.01	159.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.45	165	.25	.24	.01	159.
1.01	1.20	16	.01	.00	.01	0.	1.01	13.50	166	.25	.24	.01	159.
1.01	1.25	17	.01	0.00	.01	0.	1.01	13.55	167	.25	.24	.01	160.
1.01	1.30	18	.01	0.00	.01	0.	1.01	14.00	168	.25	.24	.01	160.
1.01	1.35	19	.01	0.00	.01	0.	1.01	14.05	169	.32	.30	.01	174.
1.01	1.40	20	.01	0.00	.01	0.	1.01	14.10	170	.32	.31	.01	191.
1.01	1.45	21	.01	0.00	.01	0.	1.01	14.15	171	.32	.31	.01	197.
1.01	1.50	22	.01	0.00	.01	0.	1.01	14.20	172	.32	.31	.01	200.
1.01	1.55	23	.01	0.00	.01	0.	1.01	14.25	173	.32	.31	.01	201.
1.01	2.00	24	.01	0.00	.01	0.	1.01	14.30	174	.32	.31	.01	201.
1.01	2.05	25	.01	0.00	.01	0.	1.01	14.35	175	.32	.31	.01	202.
1.01	2.10	26	.01	0.00	.01	0.	1.01	14.40	176	.32	.31	.01	202.
1.01	2.15	27	.01	0.00	.01	0.	1.01	14.45	177	.32	.31	.01	202.
1.01	2.20	28	.01	0.00	.01	0.	1.01	14.50	178	.32	.31	.01	202.
1.01	2.25	29	.01	0.00	.01	0.	1.01	14.55	179	.32	.31	.01	203.
1.01	2.30	30	.01	0.00	.01	0.	1.01	15.00	180	.32	.31	.01	203.
1.01	2.35	31	.01	.00	.01	0.	1.01	15.05	181	.19	.19	.00	175.
1.01	2.40	32	.01	0.00	.01	0.	1.01	15.10	182	.38	.38	.01	185.
1.01	2.45	33	.01	0.00	.01	0.	1.01	15.15	183	.38	.38	.01	225.
1.01	2.50	34	.01	0.00	.01	0.	1.01	15.20	184	.57	.56	.01	283.
1.01	2.55	35	.01	0.00	.01	0.	1.01	15.25	185	.67	.66	.01	361.
1.01	3.00	36	.01	.00	.01	0.	1.01	15.30	186	1.63	1.60	.02	625.
1.01	3.05	37	.01	.00	.01	0.	1.01	15.35	187	2.68	2.65	.03	1141.
1.01	3.10	38	.01	.00	.01	0.	1.01	15.40	188	1.05	1.04	.01	1159.
1.01	3.15	39	.01	.00	.01	0.	1.01	15.45	189	.67	.66	.01	771.
1.01	3.20	40	.01	.00	.01	0.	1.01	15.50	190	.57	.57	.01	535.
1.01	3.25	41	.01	.00	.01	0.	1.01	15.55	191	.38	.38	.00	388.
1.01	3.30	42	.01	.00	.01	0.	1.01	16.00	192	.38	.38	.00	299.
1.01	3.35	43	.01	.00	.01	1.	1.01	16.05	193	.29	.29	.00	246.
1.01	3.40	44	.01	.00	.01	1.	1.01	16.10	194	.29	.29	.00	210.
1.01	3.45	45	.01	.00	.01	1.	1.01	16.15	195	.29	.29	.00	198.
1.01	3.50	46	.01	.00	.01	1.	1.01	16.20	196	.29	.29	.00	194.
1.01	3.55	47	.01	.00	.01	1.	1.01	16.25	197	.29	.29	.00	192.
1.01	4.00	48	.01	.00	.01	1.	1.01	16.30	198	.29	.29	.00	192.
1.01	4.05	49	.01	.00	.01	1.	1.01	16.35	199	.29	.29	.00	192.
1.01	4.10	50	.01	.00	.01	1.	1.01	16.40	200	.29	.29	.00	192.
1.01	4.15	51	.01	.00	.01	1.	1.01	16.45	201	.29	.29	.00	192.
1.01	4.20	52	.01	.00	.01	1.	1.01	16.50	202	.29	.29	.00	192.
1.01	4.25	53	.01	.00	.01	1.	1.01	16.55	203	.29	.29	.00	192.
1.01	4.30	54	.01	.00	.01	2.	1.01	17.00	204	.29	.29	.00	192.
1.01	4.35	55	.01	.00	.01	2.	1.01	17.05	205	.21	.21	.00	178.

1.01	4.40	56	.01	.00	.01	[illegible]	1.01	17.10	206	.23	.23	.00	161.
1.01	4.45	57	.01	.00	.01	[illegible]	1.01	17.15	207	.23	.23	.00	154.
1.01	4.50	58	.01	.00	.01	[illegible]	1.01	17.20	208	.23	.23	.00	152.
1.01	4.55	59	.01	.00	.01	2.	1.01	17.25	209	.23	.23	.00	151.
1.01	5.00	[illegible]	.01	.00	.01	2.	1.01	17.30	210	.23	.23	.00	151.
1.01	5.05	61	.01	.00	.01	2.	1.01	17.35	211	.23	.23	.00	151.
1.01	5.10	62	.01	.00	.01	[illegible]	1.01	17.40	212	.23	.23	.00	151.
1.01	5.15	63	.01	.00	.01	2.	1.01	17.45	213	.23	.23	.00	151.
1.01	5.20	64	.01	.00	.01	2.	1.01	17.50	214	.23	.23	.00	151.
1.01	5.25	65	[illegible]	.00	.01	2.	1.01	17.55	215	.23	.23	.00	151.
1.01	5.30	[illegible]	.01	[illegible]	.01	2.	1.01	18.00	216	.23	.23	.00	151.
1.01	5.35	67	.01	.00	.01	2.	1.01	18.05	217	.02	.02	.00	101.
1.01	5.40	68	.01	.00	.01	[illegible]	1.01	18.10	218	.02	.02	.00	46.
1.01	5.46	69	.01	.00	.01	3.	1.01	18.15	219	.02	.02	.00	25.
1.01	5.50	70	.01	.00	.01	3.	1.01	18.20	220	.02	.02	.00	18.
1.01	5.55	71	.01	.00	.01	3.	1.01	18.25	221	.02	.02	.00	15.
1.01	6.00	72	.01	.00	.01	3.	1.01	18.30	222	.02	.02	.00	14.
1.01	6.05	73	.07	.02	.05	7.	1.01	18.35	223	.02	.02	.00	14.
1.01	6.10	74	.07	.02	.05	13.	1.01	18.40	224	.02	.02	.00	14.
1.01	6.15	75	.07	.03	.04	15.	1.01	18.45	225	.02	.02	.00	14.
1.01	6.20	76	.07	.03	.04	17.	1.01	18.50	226	.02	.02	.00	14.
1.01	6.25	77	.07	.03	.04	19.	1.01	18.55	227	.02	.02	.00	14.
1.01	6.30	78	.07	.03	.04	20.	1.01	19.00	228	.02	.02	.00	14.
1.01	6.35	79	.07	.03	.04	21.	1.01	19.05	229	.02	.02	.00	14.
1.01	6.40	[illegible]	.07	.03	.04	22.	1.01	19.10	230	.02	.02	.00	14.
1.01	6.45	[illegible]	.07	.04	.03	23.	1.01	19.15	231	.02	.02	.00	14.
1.01	6.50	82	.07	.04	.03	24.	1.01	19.20	232	.02	.02	.00	14.
1.01	6.55	83	.07	.04	.03	25.	1.01	19.25	233	.02	.02	.00	14.
1.01	7.00	84	.07	.04	.03	25.	1.01	19.30	234	.02	.02	.00	14.
1.01	7.05	85	.07	.04	.03	26.	1.01	19.35	235	.02	.02	.00	14.
1.01	7.10	86	.07	.04	.03	27.	1.01	19.40	236	.02	.02	.00	14.
1.01	7.15	87	.07	.04	.03	28.	1.01	19.45	237	.02	.02	.00	14.
1.01	7.20	88	.07	.04	.03	28.	1.01	19.50	238	.02	.02	.00	14.
1.01	7.25	89	.07	.04	.03	29.	1.01	19.55	239	.02	.02	.00	14.
1.01	7.30	90	.07	.05	.02	29.	1.01	20.00	240	.02	.02	.00	14.
1.01	7.35	91	.07	.05	.02	30.	1.01	20.05	241	.02	.02	.00	14.
1.01	7.40	92	.07	.05	.02	30.	1.01	20.10	242	.02	.02	.00	14.
1.01	7.45	93	.07	.05	.02	31.	1.01	20.15	243	.02	.02	.00	14.
1.01	7.50	94	.07	.05	.02	31.	1.01	20.20	244	.02	.02	.00	14.
1.01	7.55	95	.07	.05	.02	32.	1.01	20.25	245	.02	.02	.00	14.
1.01	8.00	96	.07	.05	.02	32.	1.01	20.30	246	.02	.02	.00	14.
1.01	8.05	97	.07	.05	.02	33.	1.01	20.35	247	.02	.02	.00	14.
1.01	8.10	98	.07	.05	.02	33.	1.01	20.40	248	.02	.02	.00	14.
1.01	8.15	99	.07	.05	.02	34.	1.01	20.45	249	.02	.02	.00	14.
1.01	8.20	100	.07	.05	.02	34.	1.01	20.50	250	.02	.02	.00	14.
1.01	8.25	101	.07	.05	.02	34.	1.01	20.55	251	.02	.02	.00	14.
1.01	8.30	102	.07	.05	.02	35.	1.01	21.00	252	.02	.02	.00	14.
1.01	8.35	103	.07	.05	.02	35.	1.01	21.05	253	.02	.02	.00	14.
1.01	8.40	104	.07	.05	.02	35.	1.01	21.10	254	.02	.02	.00	14.
1.01	8.45	105	.07	.05	.02	35.	1.01	21.15	255	.02	.02	.00	14.
1.01	8.50	106	.07	.05	.02	36.	1.01	21.20	256	.02	.02	.00	14.
1.01	8.55	107	.07	.06	.01	36.	1.01	21.25	257	.02	.02	.00	14.
1.01	9.00	108	.07	.06	.01	36.	1.01	21.30	258	.02	.02	.00	14.
1.01	9.05	109	.07	.06	.01	37.	1.01	21.35	259	.02	.02	.00	14.
1.01	9.10	110	.07	.06	.01	37.	1.01	21.40	260	.02	.02	.00	14.
1.01	9.15	111	.07	.06	.01	37.	1.01	21.45	261	.02	.02	.00	14.
1.01	9.20	112	.07	.06	.01	37.	1.01	21.50	262	.02	.02	.00	14.
1.01	9.25	113	.07	.06	.01	37.	1.01	21.55	263	.02	.02	.00	14.
1.01	9.30	114	.07	.06	.01	38.	1.01	22.00	264	.02	.02	.00	14.
1.01	9.35	115	.07	.06	.01	38.	1.01	22.05	265	.02	.02	.00	14.

1.01	9.40	117	.07	.06	.01	38.	1.01	22.10	266	.02	.02	.00	14.
1.01	9.45	117	.07	.06	.01	38.	1.01	22.15	267	.02	.02	.00	14.
1.01	9.50	118	.07	.06	.01	38.	1.01	22.20	268	.02	.02	.00	14.
1.01	9.55	119	.07	.06	.01	39.	1.01	22.25	26	.02	.02	.00	14.
1.01	10.00	120	.07	.06	.01	39.	1.01	22.3	27	.02	.02	.00	14.
1.01	10.05	121	.07	.06	.01	39.	1.01	22.35	271	.02	.02	.00	14.
1.01	10.10	122	.07	.06	.01	39.	1.01	22.40	272	.02	.02	.00	14.
1.01	10.15	123	.07	.06	.01	39.	1.01	22.45	273	.02	.02	.00	14.
1.01	10.20	124	.07	.06	.01	39.	1.01	22.5	274	.02	.02	.00	14.
1.01	10.25	125	.07	.06	.01	39.	1.01	22.55	275	.02	.02	.00	14.
1.01	10.30	126	.07	.06	.01	40.	1.01	23.00	276	.02	.02	.00	14.
1.01	10.35	127	.07	.06	.01	40.	1.01	23.05	277	.02	.02	.00	14.
1.01	10.40	128	.07	.06	.01	40.	1.01	23.1	278	.02	.02	.00	14.
1.01	10.45	129	.07	.06	.01	40.	1.01	23.15	279	.02	.02	.00	14.
1.01	10.50	130	.07	.06	.01	40.	1.01	23.20	280	.02	.02	.00	14.
1.01	10.55	131	.07	.06	.01	40.	1.01	23.25	281	.02	.02	.00	14.
1.01	11.00	132	.07	.06	.01	40.	1.01	23.30	282	.02	.02	.00	14.
1.01	11.05	133	.07	.06	.01	40.	1.01	23.35	283	.02	.02	.00	14.
1.01	11.10	134	.07	.06	.01	41.	1.01	23.40	284	.02	.02	.00	14.
1.01	11.15	135	.07	.06	.01	41.	1.01	23.45	285	.02	.02	.00	14.
1.01	11.20	136	.07	.06	.01	41.	1.01	23.50	286	.02	.02	.00	14.
1.01	11.25	137	.07	.06	.01	41.	1.01	23.55	287	.02	.02	.00	14.
1.01	11.30	138	.07	.06	.01	41.	1.02	0.00	288	.02	.02	.00	14.
1.01	11.35	139	.07	.06	.01	41.	1.02	.05	289	0.00	0.00	0.00	9.
1.01	11.40	140	.07	.06	.01	41.	1.02	.10	290	0.00	0.00	0.00	3.
1.01	11.45	141	.07	.06	.01	41.	1.02	.15	291	0.00	0.00	0.00	1.
1.01	11.50	142	.07	.06	.01	41.	1.02	.20	292	0.00	0.00	0.00	0.
1.01	11.55	143	.07	.06	.01	41.	1.02	.25	293	0.00	0.00	0.00	0.
1.01	12.00	144	.07	.06	.01	41.	1.02	.30	294	0.00	0.00	0.00	0.
1.01	12.05	145	.21	.19	.02	71.	1.02	.35	295	0.00	0.00	0.00	0.
1.01	12.10	146	.21	.19	.02	106.	1.02	.40	296	0.00	0.00	0.00	0.
1.01	12.15	147	.21	.19	.02	119.	1.02	.45	297	0.00	0.00	0.00	0.
1.01	12.20	148	.21	.19	.02	124.	1.02	.50	298	0.00	0.00	0.00	0.
1.01	12.25	149	.21	.19	.02	126.	1.02	.55	299	0.00	0.00	0.00	0.
1.01	12.30	150	.21	.19	.02	127.	1.02	1.00	300	0.00	0.00	0.00	0.

SUM 32.76 29.94 2.82 19714.
(832.)(760.)(72.)(568.24)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1159.	224.	68.	66.	19697.
CMS	33.	6.	2.	2.	558.
INCHES		24.47	29.94	29.94	29.94
MM		621.60	760.47	760.47	760.47
AC-FT		111.	136.	136.	136.
THOUS CU M		137.	167.	167.	167.

HYDROGRAPH AT STA/S DAM FOR PLAN 1, RTIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	2.	2.	2.	2.	2.	2.	2.
2.	2.	2.	2.	2.	2.	2.	3.	3.	3.
3.	3.	7.	13.	15.	17.	19.	20.	21.	22.
23.	24.	25.	25.	26.	27.	28.	28.	29.	29.
30.	30.	31.	31.	32.	32.	33.	33.	34.	34.

34.	35.	35.	35.	35.	36.	36.	36.	37.	37.
37.	37.	37.	38.	38.	38.	38.	38.	39.	39.
39.	39.	39.	39.	39.	40.	40.	40.	40.	40.
40.	40.	40.	41.	41.	41.	41.	41.	41.	41.
41.	41.	41.	41.	71.	106.	119.	124.	126.	127.
129.	128.	[illegible]	[illegible]	133.	170.	179.	151.	155.	157.
158.	158.	[illegible]	159.	159.	159.	160.	160.	174.	191.
197.	[illegible]	[illegible]	201.	202.	202.	202.	202.	203.	203.
175.	183.	225.	283.	761.	625.	1141.	1159.	771.	535.
[illegible]	199.	246.	210.	193.	194.	192.	192.	192.	192.
[illegible]	192.	192.	[illegible]	178.	151.	154.	152.	151.	151.
[illegible]	151.	151.	151.	151.	151.	103.	46.	25.	18.
15.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	9.	3.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1154.	[illegible]	66.	66.	19497.
CMS	33.	6.	2.	2.	558.
INCHES		24.47	29.94	29.94	29.94
MM		621.5[illegible]	760.47	760.47	760.47
AC-FT		111.	135.	135.	134.
THOUS CU M		137.	167.	167.	167.

HYDROGRAPH AT STA/S DAM FOR PLAN 1, RTIO 2

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	4.	6.	8.	9.	9.	10.	11.	11.
11.	12.	12.	13.	13.	13.	14.	14.	14.	15.
15.	15.	15.	16.	16.	16.	16.	17.	17.	17.
17.	17.	17.	18.	18.	18.	18.	18.	18.	18.
18.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	20.	20.	20.	20.	20.	20.	20.	20.	20.
20.	20.	20.	20.	20.	20.	20.	20.	21.	21.
21.	21.	21.	21.	35.	53.	60.	62.	63.	64.
64.	64.	64.	65.	65.	65.	70.	75.	77.	78.
79.	79.	79.	79.	80.	80.	80.	80.	87.	96.
99.	100.	100.	101.	101.	101.	101.	101.	101.	101.
88.	93.	112.	141.	181.	312.	570.	579.	385.	267.
194.	149.	123.	105.	99.	97.	96.	96.	96.	96.
96.	96.	96.	96.	89.	80.	77.	76.	76.	76.
76.	76.	75.	76.	76.	76.	52.	23.	13.	9.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.

7.	7.	7.	7.	7.	7.	7.	7.	4.	2.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	[illegible]79.	11[illegible].	34.	[illegible]	[illegible]84[illegible].
CMS	15.	[illegible]	1.	1.	[illegible]79.
INCHES		12.[illegible]	14.97	14.97	14.97
MM		310.75	380.24	380.29	380.24
AC-FT		[illegible]	69.	68.	68.
THOUS CU M		85.	84.	84.	84.

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HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH U/S DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
/S [illegible]	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0			0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-742.	-1

STAGE	742.00	743.00	744.56	745.20	745.78	746.60	747.28	748.78	750.25
FLOW	0.00	20.00	100.00	170.00	330.00	750.00	1361.00	3424.00	6100.00

SURFACE AREA=	0.	1.	2.	5.	6.	7.
CAPACITY=	0.	4.	11.	53.	105.	170.
ELEVATION=	730.	742.	747.	763.	770.	780.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
742.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
745.0	0.0	0.0	0.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
10.	.50	738.00	1.00	742.00	745.00

STATION /S DAM, PLAN 1, RATIO 1

BEGIN DAM FAILURE AT 13.42 HOURS

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STORAGE

STAGE

742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0
742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0
742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0
742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0
742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0
742.0	742.	742.0	742.0	742.1	742.1	742.1	742.1	742.1	742.1
742.1	742.1	742.1	742.1	742.1	742.1	742.1	742.1	742.1	742.1
742.1	742.1	742.1	742.2	742.2	742.3	742.4	742.5	742.5	742.6
742.7	742.7	742.8	742.8	742.9	742.9	743.0	743.0	743.1	743.1
743.1	743.1	743.2	743.2	743.2	743.2	743.2	743.2	743.2	743.2
743.2	743.3	743.3	743.3	743.3	743.3	743.3	743.3	743.3	743.3
743.3	743.3	743.3	743.3	743.3	743.3	743.3	743.3	743.3	743.4
743.4	743.4	743.4	743.4	743.4	743.4	743.4	743.4	743.4	743.4
743.4	743.4	743.4	743.4	743.4	743.4	743.4	743.4	743.4	743.4
743.4	743.4	743.4	743.4	743.5	743.7	744.0	744.2	744.4	744.5
744.6	744.7	744.8	744.9	744.8	744.9	744.8	744.7	744.9	745.0
745.0	745.0	745.0	744.6	744.6	744.4	744.1	743.8	743.5	743.1
742.8	742.4	741.5	741.5	741.4	741.3	741.3	741.2	741.2	741.2
741.2	741.1	741.2	741.5	742.0	742.9	744.5	745.5	745.3	744.4
743.6	742.8	742.3	741.8	741.5	741.3	741.2	741.2	741.2	741.1
741.1	741.1	741.1	741.1	741.1	741.0	740.9	740.9	740.7	740.7
740.7	740.7	740.7	740.7	740.7	740.7	740.5	740.1	739.6	739.2
739.0	738.8	738.7	738.7	738.6	738.6	738.6	738.6	738.5	738.5
738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6
738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.5	738.6
738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6
738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6
738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6
738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.6	738.5	738.5
739.4	738.3	738.2	738.2	738.2	738.1	738.1	738.1	738.1	738.1

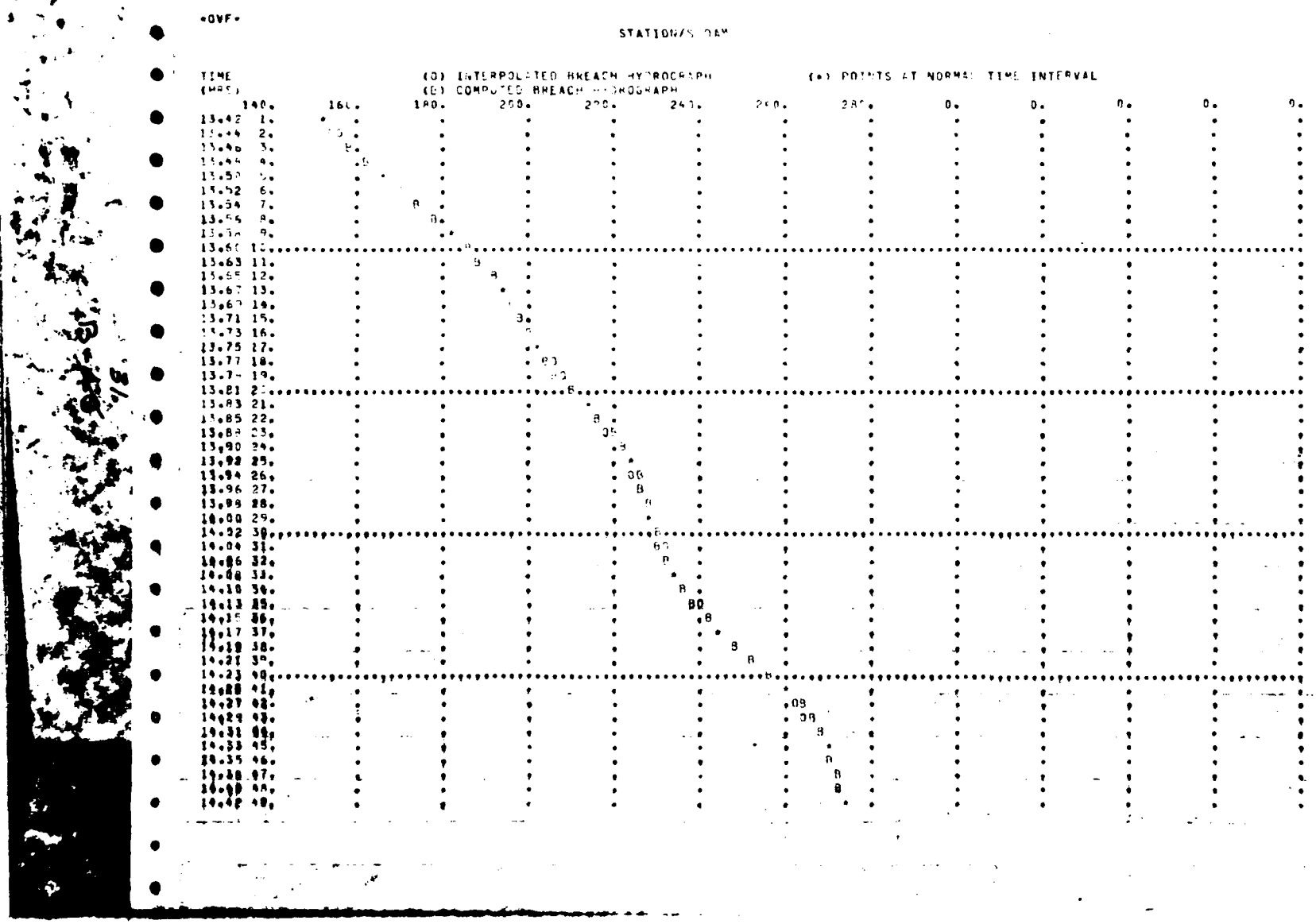
PEAK OUTFLOW IS 1091. AT TIME 15.67 HOURS

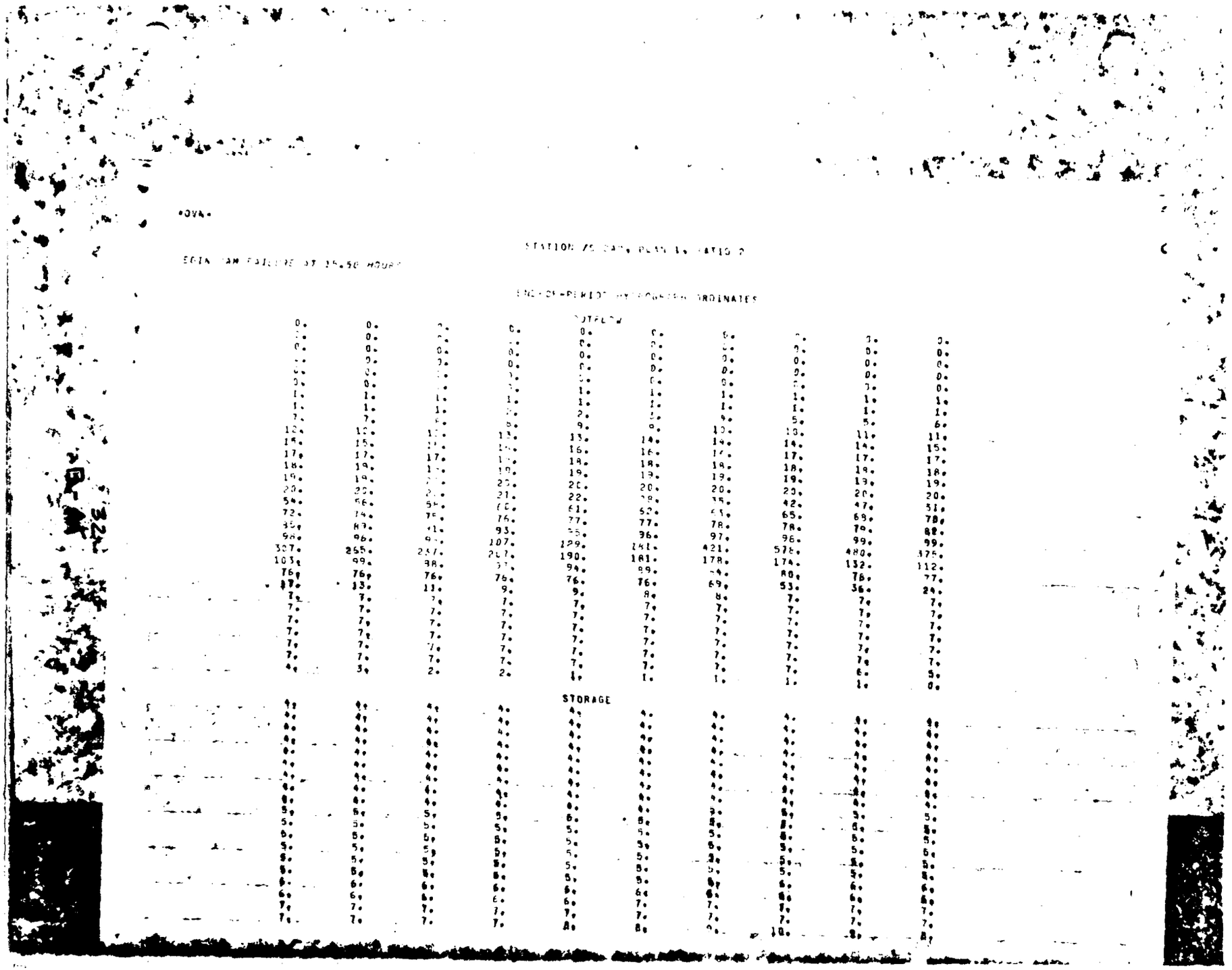
	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1091.	231.	70.	67.	20105.
CMS	31.	7.	2.	2.	569.
INCHES		25.27	30.56	30.56	30.56
MM		641.86	776.22	776.22	776.22
AC-FT		114.	138.	138.	138.
THOUS CU M		141.	171.	171.	171.

B-29

THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .021 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .042 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATION WITH THE COMPUTED BREACH HYDROGRAPH.
INTERIM RATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME SINCE BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)		COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
13.417	0.000	149.		149.		0.	0.	0.
13.438	.021	151.		150.		1.	1.	0.
13.458	.042	153.		151.		1.	2.	0.
13.479	.063	155.		153.		1.	2.	0.
13.500	.083	157.		156.		0.	2.	0.
13.521	.104	159.		159.		-0.	2.	0.
13.542	.125	161.		163.		-0.	2.	0.
13.563	.146	164.		166.		-0.	1.	0.
13.583	.167	167.		167.		0.	1.	0.
13.604	.188	169.		169.		-0.	1.	0.
13.625	.208	169.		169.		-1.	1.	0.
13.646	.229	171.		172.		-0.	0.	0.
13.667	.250	174.		174.		0.	0.	0.
13.688	.271	176.		177.		-0.	-0.	-0.
13.708	.292	178.		179.		-0.	-1.	-0.
13.729	.313	180.		181.		-0.	-1.	-0.
13.750	.333	182.		182.		0.	-1.	-0.
13.771	.354	185.		184.		1.	0.	0.
13.792	.375	188.		186.		2.	2.	0.
13.813	.396	211.		210.		1.	3.	0.
13.833	.417	214.		214.		0.	3.	0.
13.854	.438	216.		217.		-1.	2.	0.
13.875	.458	219.		219.		-1.	2.	0.
13.896	.479	221.		222.		-1.	1.	0.
13.917	.500	224.		224.		0.	1.	0.
13.938	.521	225.		225.		-0.	1.	0.
13.958	.542	226.		227.		-1.	0.	0.
13.979	.563	227.		228.		-0.	-0.	-0.
14.000	.583	228.		228.		0.	-0.	-0.
14.021	.604	230.		229.		1.	0.	0.
14.042	.625	231.		231.		1.	1.	0.
14.063	.646	233.		232.		0.	1.	0.
14.083	.667	234.		234.		0.	1.	0.
14.104	.688	237.		236.		0.	2.	0.
14.125	.708	239.		238.		1.	2.	0.
14.146	.729	242.		242.		0.	3.	0.
14.167	.750	245.		245.		0.	3.	0.
14.188	.771	248.		248.		1.	4.	0.
14.208	.792	252.		251.		1.	5.	0.
14.229	.812	256.		256.		0.	5.	0.
14.250	.833	260.		260.		-0.	5.	0.
14.271	.854	262.		263.		-1.	4.	0.
14.292	.875	264.		266.		-1.	3.	0.
14.313	.896	267.		269.		-1.	2.	0.
14.333	.917	270.		270.		0.	2.	0.
14.354	.937	271.		271.		-0.	2.	0.
14.375	.958	272.		272.		0.	2.	0.
14.396	.979	273.		272.		1.	3.	0.
14.417	1.000	274.		274.		0.	3.	0.


OVF
STATION/S DAM
TIME (HRS)
(O) INTERPOLATED BREACH HYDROGRAPH
(B) COMPUTED BREACH HYDROGRAPH
(+) POINTS AT NORMAL TIME INTERVAL
140. 160. 180. 200. 220. 240. 260. 280. 0. 0. 0. 0. 0.



9.	7.	6.	5.	5.	4.	4.	3.	3.	2.
2.	2.	[illegible]	2.	2.	2.	2.	2.	2.	2.
2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
2.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.

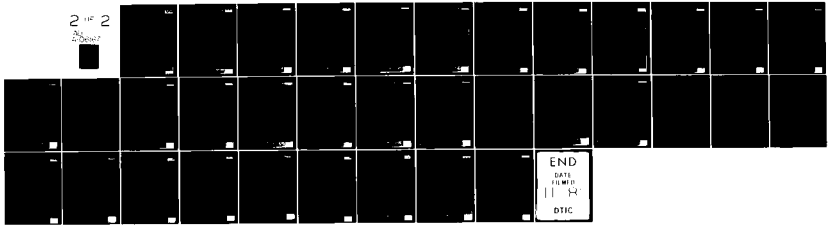
STAGE

742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0
742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0
742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0
742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0
742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0
742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0
742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.0	742.1	742.1
742.1	742.1	742.1	742.1	742.1	742.2	742.2	742.2	742.3	742.3
742.3	742.4	742.4	742.4	742.4	742.5	742.5	742.5	742.5	742.6
742.6	742.6	742.6	742.6	742.7	742.7	742.7	742.7	742.7	742.7
742.7	742.8	742.8	742.8	742.8	742.8	742.8	742.8	742.8	742.8
742.9	742.9	742.9	742.9	742.9	742.9	742.9	742.9	742.9	742.9
742.9	742.9	742.9	742.9	742.9	742.9	743.0	743.0	743.0	743.0
743.0	743.0	743.0	743.0	743.0	743.0	743.0	743.0	743.0	743.0
743.0	743.0	743.0	743.0	743.0	743.2	743.3	743.4	743.5	743.6
743.7	743.7	743.7	743.8	743.9	743.8	743.8	743.9	743.9	744.0
744.0	744.0	744.1	744.1	744.1	744.1	744.1	744.1	744.2	744.2
744.3	744.3	744.4	744.4	744.5	744.5	744.5	744.5	744.5	744.5
744.5	744.5	744.5	744.6	744.8	745.2	745.8	746.0	745.8	745.4
744.9	744.4	743.9	743.3	742.7	742.2	741.6	740.9	740.5	740.2
740.1	740.1	740.0	740.0	740.0	739.9	739.9	739.8	739.8	739.8
739.7	739.7	739.7	739.7	739.7	739.7	739.6	739.4	739.1	738.9
738.7	738.6	738.5	738.4	738.4	738.4	738.4	738.4	738.4	738.4
738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4
738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4
738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4
738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4
738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4
738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.4	738.3
738.3	738.2	738.2	738.1	738.1	738.1	738.1	738.1	738.1	738.1

PEAK OUTFLOW IS 576. AT TIME 15.67 HOURS

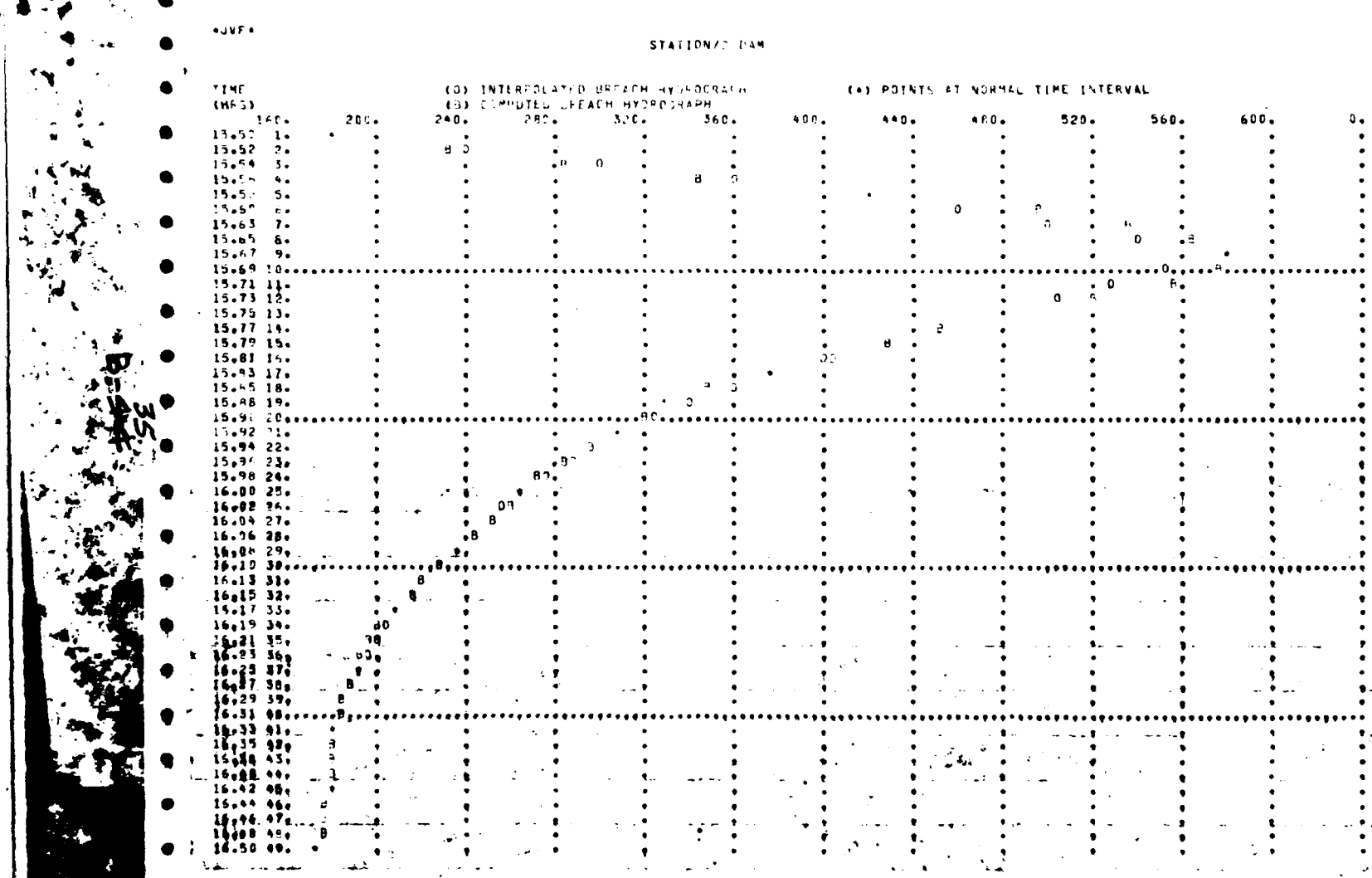
	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	578.	114.	35.	34.	10834.
CMS	16.	3.	1.	1.	290.
INCHES		12.96	15.56	15.56	15.56
MM		329.13	395.12	396.12	395.12
AC-FT		59.	70.	70.	70.
THOUS CU M		72.	87.	87.	87.

AD-A106 167 PRC CONSOER TOWNSEND INC ST LOUIS MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. BENSON LAKE DAM (MO 30667), MISSOU--ETC(U)
SEP 80 W G SHIFRIN DACW43-80-C-0094
UNCLASSIFIED NL



THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .021 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .043 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	-	COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
15.[illegible]	[illegible]	[illegible]		[illegible]		0.	0.	0.
15.[illegible]	.021	[illegible]		230.		11.	11.	0.
15.[illegible]	.042	[illegible]		[illegible]		16.	26.	0.
15.[illegible]	.063	[illegible]		[illegible]		16.	42.	0.
15.[illegible]	.083	[illegible]		[illegible]		[illegible]	42.	0.
15.[illegible]	.104	[illegible]		[illegible]		-34.	[illegible]	[illegible]
15.[illegible]	.125	[illegible]		537.		-37.	-29.	-0.
15.646	.146	[illegible]		563.		-24.	-53.	-0.
15.667	.167	[illegible]		[illegible]		-0.	-53.	-0.
15.688	.188	[illegible]		577.		-24.	-76.	-0.
15.7[illegible]	.208	[illegible]		555.		-26.	-102.	-0.
15.7[illegible]	.229	[illegible]		521.		-16.	-118.	-0.
15.750	.250	[illegible]		[illegible]		0.	-118.	-0.
15.771	.271	[illegible]		[illegible]		1.	-118.	-0.
15.792	.292	[illegible]		[illegible]		-1.	-119.	-0.
15.813	.313	[illegible]		[illegible]		-1.	-120.	-0.
15.833	.333	[illegible]		375.		0.	-120.	-0.
15.854	.354	[illegible]		386.		10.	-111.	-0.
15.875	.375	341.		327.		14.	-97.	-0.
15.896	.396	324.		319.		4.	-91.	-0.
15.917	.417	307.		307.		0.	-91.	-0.
15.938	.438	297.		295.		2.	-89.	-0.
15.958	.458	285.		283.		3.	-86.	-0.
15.979	.479	276.		271.		5.	-81.	-0.
16.000	.500	265.		265.		0.	-81.	-0.
16.021	.521	258.		258.		-1.	-82.	-0.
16.042	.542	251.		252.		-1.	-82.	-0.
16.063	.563	244.		244.		-0.	-83.	-0.
16.083	.583	237.		237.		0.	-83.	-0.
16.104	.604	229.		229.		0.	-83.	-0.
16.125	.625	222.		222.		0.	-82.	-0.
16.146	.646	215.		214.		0.	-82.	-0.
16.167	.667	207.		207.		0.	-82.	-0.
16.188	.688	203.		200.		3.	-79.	-0.
16.208	.708	199.		194.		4.	-75.	-0.
16.229	.729	194.		192.		2.	-73.	-0.
16.250	.750	190.		190.		0.	-73.	-0.
16.271	.771	188.		188.		-0.	-73.	-0.
16.292	.792	186.		186.		-0.	-73.	-0.
16.313	.812	183.		183.		-0.	-73.	-0.
16.333	.833	181.		181.		0.	-73.	-0.
16.354	.854	180.		179.		2.	-71.	-0.
16.375	.875	180.		179.		1.	-71.	-0.
16.396	.896	179.		179.		0.	-70.	-0.
16.417	.917	178.		178.		0.	-70.	-0.
16.438	.937	177.		177.		-0.	-71.	-0.
16.458	.958	176.		177.		-0.	-71.	-0.
16.479	.979	175.		175.		-0.	-71.	-0.
16.500	1.000	174.		174.		0.	-71.	-0.


OVER
STATION/S DAM
TIME
(HRS)
(O) INTERPOLATED BREACH HYDROGRAPH
(B) COMPUTED BREACH HYDROGRAPH
(*) POINTS AT NORMAL TIME INTERVAL
160. 200. 240. 280. 320. 360. 400. 440. 480. 520. 560. 600. 0.

DYN

HYDROGRAPH ROUTING

CHANNEL ROUTING

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	S -D/S	1	0	0	0	0	1	0	0

HOUR SO DATA

KLOSS	CLOSS	AVG	IPES	ISAME	IOPT	ICMP	LSTR
0.0	0.010	0.00	1	1	0	0	0

	NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
	1	0	0	0.001	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

	SV(1)	SV(2)	SV(3)	ELEVT	ELMAX	RLNTH	SEL
	.0500	.0500	.0500	720.	740.00	1000.	.02500

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 740.00 40.00 730.00 90.00 723.0 95.00 720.00 100.00 720.00
110.00 723.00 180.00 730.00 250.00 740.00

STORAGE	0.00	.28	.65	1.11	1.68	3.08	4.72	6.79	9.30	12.25
	15.62	19.28	23.22	27.44	31.95	36.73	41.79	47.13	52.75	58.65
OUTFLOW	0.00	53.46	180.55	386.70	749.57	1324.89	2181.81	3376.07	4962.69	6989.72
	9579.81	12738.81	16401.67	20584.81	25306.43	30585.25	36440.21	42890.35	49954.69	57652.15
STAGE	720.00	721.85	722.11	723.16	724.21	725.26	726.32	727.37	728.42	729.47
	730.53	731.58	732.63	733.68	734.74	735.79	736.84	737.89	738.95	740.00
FLOW	0.00	53.46	180.55	386.70	749.57	1324.89	2181.81	3376.07	4962.69	6989.72
	9579.81	12738.81	16401.67	20584.81	25306.43	30585.25	36440.21	42890.35	49954.69	57652.15

STATION S -D/S, PLAN 1, PTIO 1

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	2.	2.	2.	2.	2.	2.	2.	2.
2.	2.	2.	3.	4.	5.	7.	8.	9.	11.
12.	13.	14.	16.	17.	18.	19.	20.	22.	23.
25.	26.	27.	28.	29.	30.	30.	31.	31.	32.
32.	33.	34.	34.	34.	35.	35.	35.	35.	36.

36.	36.	36.	37.	37.	37.	37.	38.	38.	38.
38.	38.	38.	39.	39.	39.	39.	39.	39.	40.
40.	40.	42.	40.	40.	40.	40.	41.	41.	41.
41.	41.	41.	41.	43.	49.	61.	76.	87.	95.
104.	114.	120.	123.	125.	127.	129.	134.	140.	146.
150.	163.	175.	193.	200.	212.	221.	227.	232.	241.
255.	267.	273.	253.	219.	210.	207.	204.	203.	203.
146.	169.	152.	218.	264.	368.	628.	985.	1040.	795.
593.	444.	344.	261.	233.	216.	203.	197.	194.	193.
172.	192.	137.	193.	139.	181.	171.	142.	157.	134.
157.	152.	1 1.	151.	151.	151.	144.	118.	82.	53.
41.	33.	23.	19.	17.	15.	15.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	13.	12.
9.	7.	5.	4.	3.	2.	2.	1.	1.	1.
				STOR					
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	2.	2.	2.	2.
2.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
				STAGE					
720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0
720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0
720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0
720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0
720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0
720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0
720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0

720.0	720.0	720.0	720.1	720.1	720.1	720.1	720.2	720.2	720.2
720.2	720.3	[illegible]	[illegible]	720.	[illegible]	720.6	720.6	720.6	720.6
720.5	720.5	720.6	720.6	720.7	[illegible]	720.7	720.7	720.7	720.7
720.6	720.6	720.7	720.7	720.7	[illegible]	720.7	720.7	720.7	720.7
720.7	720.7	720.7	720.7	720.7	720.7	720.7	720.7	720.7	720.7
720.8	720.[illegible]	720.8	720.8	720.[illegible]	720.8	720.8	720.8	720.8	720.8
720.8	720.8	720.8	720.8	720.8	720.8	720.8	720.8	720.8	720.8
720.8	720.8	720.8	720.8	720.9	721.0	721.1	721.2	721.3	721.4
721.5	721.6	721.7	721.8	721.9	721.7	721.7	721.7	721.8	721.8
721.9	721.9	722.1	722.2	722.3	722.3	722.3	722.3	722.4	722.4
722.5	722.5	722.6	722.5	722.5	722.3	722.2	722.2	722.2	722.2
722.2	722.1	722.0	722.1	722.5	724.1	723.9	724.6	724.7	724.3
723.7	723.3	722.9	722.6	722.4	722.3	722.2	722.2	722.2	722.2
722.2	722.2	722.2	722.2	722.2	722.1	722.0	722.0	721.9	721.9
721.9	721.9	721.9	721.9	721.9	721.9	721.8	721.6	721.5	721.1
721.8	720.6	720.5	720.4	720.4	720.3	720.3	720.3	720.3	720.3
720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3
720.3	720.3	720.4	720.3	720.3	720.3	720.3	720.3	720.3	720.3
720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3
720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3
720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.2
720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.2
720.2	720.1	720.1	720.1	720.1	720.0	720.0	720.0	720.0	720.0

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1040.	231.	70.	67.	20105.
CMS	29.	7.	2.	2.	569.
INCHES		25.36	30.56	30.56	30.56
MM		641.52	776.19	776.19	776.19
1C-FT		114.	138.	138.	138.
THOUS CU M		141.	171.	171.	171.

MAXIMUM STORAGE = [illegible]

MAXIMUM STAGE IS 724.7

STATION S -D/S, PLAN 1, RTIO 2

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	2.	3.	4.	5.	7.	9.
9.	7.	7.	8.	8.	9.	10.	10.	11.	11.
11.	12.	12.	13.	13.	13.	14.	14.	14.	16.
15.	15.	15.	16.	16.	16.	16.	16.	17.	17.
17.	17.	17.	17.	18.	18.	18.	18.	18.	18.
18.	18.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	20.	20.	20.	20.	20.	20.	20.	20.
20.	20.	20.	20.	21.	24.	30.	37.	53.	67.
61.	56.	56.	59.	60.	61.	63.	64.	67.	69.
73.	73.	74.	75.	76.	77.	78.	78.	79.	81.
84.	87.	90.	93.	94.	96.	97.	98.	98.	99.

99.	[illegible]	97.	103.	119.	158.	329.	539.	526.	404.
127.	277.	245.	217.	195.	184.	179.	176.	151.	120.
107.	101.	96.	97.	95.	92.	86.	81.	79.	77.
76.	75.	75.	[illegible]	76.	76.	72.	60.	46.	33.
24.	17.	13.	11.	9.	8.	[illegible]	8.	7.	[illegible]
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	7.
7.	7.	7.	7.	7.	7.	7.	7.	7.	6.
5.	4.	3.	2.	2.	1.	1.	1.	1.	1.

STOR

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STAGE

720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0
720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0
720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0
720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0
720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0
720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0
720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0
720.0	720.0	720.0	720.0	720.0	720.1	720.1	720.1	720.1	720.1
720.1	720.1	720.1	720.2	720.2	720.2	720.2	720.2	720.2	720.2
720.2	720.2	720.2	720.2	720.3	720.3	720.3	720.3	720.3	720.3
720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3	720.3
720.3	720.3	720.3	720.3	720.3	720.3	720.4	720.4	720.4	720.4
720.4	720.4	720.4	720.4	720.4	720.4	720.4	720.4	720.4	720.4
720.4	720.4	720.4	720.4	720.4	720.4	720.4	720.4	720.4	720.4

720.4	720.4	720.4	720.4	720.4	720.5	720.6	720.7	720.8	720.9
721.0	721.1	721.1	721.1	721.1	721.1	721.1	721.1	721.2	721.2
721.2	721.2	721.2	721.2	721.2	721.2	721.3	721.3	721.3	721.3
721.3	721.3	721.4	721.4	721.4	721.4	721.4	721.4	721.4	721.4
721.4	721.4	721.4	721.5	721.6	721.9	722.9	723.6	723.6	723.2
722.9	722.6	722.4	722.3	722.2	722.1	722.1	722.1	721.9	721.6
721.5	721.4	721.4	721.4	721.4	721.4	721.3	721.3	721.3	721.2
721.2	721.2	721.2	721.2	721.2	721.2	721.2	721.1	720.9	720.7
720.5	720.2	720.3	720.2	720.2	720.2	720.2	720.1	720.1	720.1
720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1
720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1
720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1
720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1
720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1
720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1	720.1
720.1	720.1	720.1	720.0	720.0	720.0	720.0	720.0	720.0	720.0

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	539.	118.	36.	34.	10234.
CMS	15.	3.	1.	1.	290.
INCHES		12.95	15.56	15.56	15.56
MM		328.90	395.11	395.11	395.11
AC-FT		59.	70.	70.	70.
THOUS CU M		72.	87.	87.	87.

MAXIMUM STORAGE = 1.

MAXIMUM STAGE IS 723.6

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF CALCULATION FOR BENSON LAKE DAM RUNOFF AREA

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
30667	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.15	0.00	.15	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.20	100.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-80.00	-0.00	0.00

CURVE NO = -80.00 WETNESS = -1.00 EFFECT CN = 80.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .08

B-45
40

RECESSION DATA
STRTQ= [illegible] QRCSN= [illegible] RTIOR= 1.00

TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

UNIT HYDROGRAPH 7 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .08 VOL= 1.00
455. 459. 152. 52. 17. 6. 2.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.35	151	.21	.20	.01	218.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.40	152	.21	.20	.01	219.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.45	153	.21	.20	.01	220.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.50	154	.21	.20	.01	220.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.55	155	.21	.20	.01	221.
1.01	.30	6	.01	0.00	.01	0.	1.01	13.00	156	.21	.20	.01	222.
1.01	.35	7	.01	0.00	.01	0.	1.01	13.05	157	.25	.24	.01	240.
1.01	.40	8	.01	0.00	.01	0.	1.01	13.10	158	.25	.24	.01	258.
1.01	.45	9	.01	0.00	.01	0.	1.01	13.15	159	.25	.24	.01	265.
1.01	.50	10	.01	0.00	.01	0.	1.01	13.20	160	.25	.24	.01	268.
1.01	.55	11	.01	0.00	.01	0.	1.01	13.25	161	.25	.24	.01	269.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.30	162	.25	.24	.01	270.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.35	163	.25	.24	.01	270.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.40	164	.25	.24	.01	271.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.45	165	.25	.24	.01	271.
1.01	1.20	16	.01	0.00	.01	0.	1.01	13.50	166	.25	.24	.01	272.
1.01	1.25	17	.01	0.00	.01	0.	1.01	13.55	167	.25	.24	.01	272.
1.01	1.30	18	.01	0.00	.01	0.	1.01	14.00	168	.25	.24	.01	273.
1.01	1.35	19	.01	0.00	.01	0.	1.01	14.05	169	.32	.30	.01	304.
1.01	1.40	20	.01	0.00	.01	0.	1.01	14.10	170	.32	.31	.01	328.
1.01	1.45	21	.01	0.00	.01	0.	1.01	14.15	171	.32	.31	.01	338.
1.01	1.50	22	.01	0.00	.01	0.	1.01	14.20	172	.32	.31	.01	341.
1.01	1.55	23	.01	0.00	.01	0.	1.01	14.25	173	.32	.31	.01	343.
1.01	2.00	24	.01	0.00	.01	0.	1.01	14.30	174	.32	.31	.01	344.
1.01	2.05	25	.01	0.00	.01	0.	1.01	14.35	175	.32	.31	.01	344.
1.01	2.10	26	.01	0.00	.01	0.	1.01	14.40	176	.32	.31	.01	345.
1.01	2.15	27	.01	0.00	.01	0.	1.01	14.45	177	.32	.31	.01	345.
1.01	2.20	28	.01	0.00	.01	0.	1.01	14.50	178	.32	.31	.01	345.
1.01	2.25	29	.01	0.00	.01	0.	1.01	14.55	179	.32	.31	.01	346.
1.01	2.30	30	.01	0.00	.01	0.	1.01	15.00	180	.32	.31	.01	346.
1.01	2.35	31	.01	0.00	.01	0.	1.01	15.05	181	.19	.19	.00	293.
1.01	2.40	32	.01	0.00	.01	0.	1.01	15.10	182	.38	.38	.01	320.
1.01	2.45	33	.01	0.00	.01	0.	1.01	15.15	183	.38	.38	.01	388.
1.01	2.50	34	.01	0.00	.01	0.	1.01	15.20	184	.57	.56	.01	492.
1.01	2.55	35	.01	0.00	.01	0.	1.01	15.25	185	.67	.66	.01	628.
1.01	3.00	36	.01	.00	.01	0.	1.01	15.30	186	1.63	1.60	.02	1113.
1.01	3.05	37	.01	.00	.01	0.	1.01	15.35	187	2.68	2.65	.03	2026.
1.01	3.10	38	.01	.00	.01	0.	1.01	15.40	188	1.05	1.04	.01	1959.
1.01	3.15	39	.01	.00	.01	0.	1.01	15.45	189	.67	.66	.01	1268.
1.01	3.20	40	.01	.00	.01	0.	1.01	15.50	190	.57	.57	.01	880.
1.01	3.25	41	.01	.00	.01	1.	1.01	15.55	191	.38	.38	.00	637.
1.01	3.30	42	.01	.00	.01	1.	1.01	16.00	192	.38	.38	.00	496.
1.01	3.35	43	.01	.00	.01	1.	1.01	16.05	193	.29	.29	.00	410.
1.01	3.40	44	.01	.00	.01	1.	1.01	16.10	194	.29	.29	.00	383.
1.01	3.45	45	.01	.00	.01	1.	1.01	16.15	195	.29	.29	.00	336.
1.01	3.50	46	.01	.00	.01	1.	1.01	16.20	196	.29	.29	.00	330.
1.01	3.55	47	.01	.00	.01	2.	1.01	16.25	197	.29	.29	.00	329.
1.01	4.00	48	.01	.00	.01	2.	1.01	16.30	198	.29	.29	.00	328.
1.01	4.05	49	.01	.00	.01	2.	1.01	16.35	199	.29	.29	.00	327.

1.01	4.10	59	.01	.00	.01	3.	1.01	16.40	230	.29	.29	.00	327.
1.01	4.15	60	.01	.00	.01	3.	1.01	16.45	231	.29	.29	.00	328.
1.01	4.20	61	.01	.00	.01	3.	1.01	16.50	232	.29	.29	.00	328.
1.01	4.25	62	.01	.00	.01	3.	1.01	16.55	233	.29	.29	.00	328.
1.01	4.30	63	.01	.00	.01	3.	1.01	17.00	234	.29	.29	.00	328.
1.01	4.35	64	.01	.00	.01	3.	1.01	17.05	235	.23	.23	.00	301.
1.01	4.40	65	.01	.00	.01	3.	1.01	17.10	236	.23	.23	.00	272.
1.01	4.45	66	.01	.00	.01	3.	1.01	17.15	237	.23	.23	.00	262.
1.01	4.50	67	.01	.00	.01	3.	1.01	17.20	238	.23	.23	.00	259.
1.01	4.55	68	.01	.00	.01	3.	1.01	17.25	239	.23	.23	.00	258.
1.01	5.00	69	.01	.00	.01	3.	1.01	17.30	240	.23	.23	.00	258.
1.01	5.05	70	.01	.00	.01	3.	1.01	17.35	241	.23	.23	.00	258.
1.01	5.10	71	.01	.00	.01	4.	1.01	17.40	242	.23	.23	.00	258.
1.01	5.15	72	.01	.00	.01	4.	1.01	17.45	243	.23	.23	.00	258.
1.01	5.20	73	.01	.00	.01	4.	1.01	17.50	244	.23	.23	.00	258.
1.01	5.25	74	.01	.00	.01	4.	1.01	17.55	245	.23	.23	.00	258.
1.01	5.30	75	.01	.00	.01	4.	1.01	18.00	246	.23	.23	.00	258.
1.01	5.35	76	.01	.00	.01	4.	1.01	18.05	247	.02	.02	.00	167.
1.01	5.40	77	.01	.00	.01	4.	1.01	18.10	248	.02	.02	.00	71.
1.01	5.45	78	.01	.00	.01	4.	1.01	18.15	249	.02	.02	.00	29.
1.01	5.50	79	.01	.00	.01	5.	1.01	18.20	250	.02	.02	.00	25.
1.01	5.55	80	.01	.00	.01	5.	1.01	18.25	251	.02	.02	.00	24.
1.01	6.00	81	.01	.00	.01	5.	1.01	18.30	252	.02	.02	.00	24.
1.01	6.05	82	.01	.00	.01	5.	1.01	18.35	253	.02	.02	.00	23.
1.01	6.10	83	.01	.00	.01	5.	1.01	18.40	254	.02	.02	.00	23.
1.01	6.15	84	.01	.00	.01	5.	1.01	18.45	255	.02	.02	.00	23.
1.01	6.20	85	.01	.00	.01	5.	1.01	18.50	256	.02	.02	.00	23.
1.01	6.25	86	.01	.00	.01	5.	1.01	18.55	257	.02	.02	.00	23.
1.01	6.30	87	.01	.00	.01	5.	1.01	19.00	258	.02	.02	.00	23.
1.01	6.35	88	.01	.00	.01	5.	1.01	19.05	259	.02	.02	.00	23.
1.01	6.40	89	.01	.00	.01	5.	1.01	19.10	260	.02	.02	.00	23.
1.01	6.45	90	.01	.00	.01	5.	1.01	19.15	261	.02	.02	.00	23.
1.01	6.50	91	.01	.00	.01	5.	1.01	19.20	262	.02	.02	.00	23.
1.01	6.55	92	.01	.00	.01	5.	1.01	19.25	263	.02	.02	.00	23.
1.01	7.00	93	.01	.00	.01	5.	1.01	19.30	264	.02	.02	.00	23.
1.01	7.05	94	.01	.00	.01	5.	1.01	19.35	265	.02	.02	.00	23.
1.01	7.10	95	.01	.00	.01	5.	1.01	19.40	266	.02	.02	.00	23.
1.01	7.15	96	.01	.00	.01	5.	1.01	19.45	267	.02	.02	.00	23.
1.01	7.20	97	.01	.00	.01	5.	1.01	19.50	268	.02	.02	.00	23.
1.01	7.25	98	.01	.00	.01	5.	1.01	19.55	269	.02	.02	.00	23.
1.01	7.30	99	.01	.00	.01	5.	1.01	20.00	270	.02	.02	.00	23.
1.01	7.35	100	.01	.00	.01	5.	1.01	20.05	271	.02	.02	.00	23.
1.01	7.40	101	.01	.00	.01	5.	1.01	20.10	272	.02	.02	.00	23.
1.01	7.45	102	.01	.00	.01	5.	1.01	20.15	273	.02	.02	.00	23.
1.01	7.50	103	.01	.00	.01	5.	1.01	20.20	274	.02	.02	.00	23.
1.01	7.55	104	.01	.00	.01	5.	1.01	20.25	275	.02	.02	.00	23.
1.01	8.00	105	.01	.00	.01	5.	1.01	20.30	276	.02	.02	.00	23.
1.01	8.05	106	.01	.00	.01	5.	1.01	20.35	277	.02	.02	.00	23.
1.01	8.10	107	.01	.00	.01	5.	1.01	20.40	278	.02	.02	.00	23.
1.01	8.15	108	.01	.00	.01	5.	1.01	20.45	279	.02	.02	.00	23.
1.01	8.20	109	.01	.00	.01	5.	1.01	20.50	280	.02	.02	.00	23.
1.01	8.25	110	.01	.00	.01	5.	1.01	20.55	281	.02	.02	.00	23.
1.01	8.30	111	.01	.00	.01	5.	1.01	21.00	282	.02	.02	.00	23.
1.01	8.35	112	.01	.00	.01	5.	1.01	21.05	283	.02	.02	.00	23.
1.01	8.40	113	.01	.00	.01	5.	1.01	21.10	284	.02	.02	.00	23.
1.01	8.45	114	.01	.00	.01	5.	1.01	21.15	285	.02	.02	.00	23.
1.01	8.50	115	.01	.00	.01	5.	1.01	21.20	286	.02	.02	.00	23.
1.01	8.55	116	.01	.00	.01	5.	1.01	21.25	287	.02	.02	.00	23.
1.01	9.00	117	.01	.00	.01	5.	1.01	21.30	288	.02	.02	.00	23.
1.01	9.05	118	.01	.00	.01	5.	1.01	21.35	289	.02	.02	.00	23.

1.01	9.10	110	.07	.06	.01	63.	1.01	21.40	260	.02	.02	.00	23.
1.01	9.15	111	.07	.06	.01	63.	1.01	21.45	261	.02	.02	.00	23.
1.01	9.20	112	.07	.06	.01	63.	1.01	21.50	262	.02	.02	.00	23.
1.01	9.25	113	.07	.06	.01	64.	1.01	21.55	263	.02	.02	.00	23.
1.01	9.30	114	.07	.06	.01	64.	1.01	22.00	264	.02	.02	.00	23.
1.01	9.35	115	.07	.06	.01	64.	1.01	22.05	265	.02	.02	.00	23.
1.01	9.40	116	.07	.06	.01	65.	1.01	22.10	266	.02	.02	.00	23.
1.01	9.45	117	.07	.06	.01	65.	1.01	22.15	267	.02	.02	.00	23.
1.01	9.50	118	.07	.06	.01	65.	1.01	22.2	268	.02	.02	.00	23.
1.01	9.5	119	.07	.06	.01	66.	1.01	22.25	269	.02	.02	.00	23.
1.01	10.00	120	.07	.06	.01	66.	1.01	22.30	270	.02	.02	.00	23.
1.01	10.05	121	.07	.06	.01	66.	1.01	22.35	271	.02	.02	.00	23.
1.01	10.1	122	.07	.06	.01	67.	1.01	22.40	272	.02	.02	.00	23.
1.01	10.15	123	.07	.06	.01	67.	1.01	22.45	273	.02	.02	.00	23.
1.01	10.20	124	.07	.06	.01	67.	1.01	22.50	274	.02	.02	.00	23.
1.01	10.25	125	.07	.06	.01	67.	1.01	22.55	275	.02	.02	.00	23.
1.01	10.30	126	.07	.06	.01	68.	1.01	23.00	276	.02	.02	.00	23.
1.01	10.35	127	.07	.06	.01	68.	1.01	23.05	277	.02	.02	.00	23.
1.01	10.40	128	.07	.06	.01	68.	1.01	23.10	278	.02	.02	.00	23.
1.01	10.45	129	.07	.06	.01	68.	1.01	23.15	279	.02	.02	.00	23.
1.01	10.50	130	.07	.06	.01	68.	1.01	23.2	280	.02	.02	.00	23.
1.01	10.55	131	.07	.06	.01	69.	1.01	23.25	281	.02	.02	.00	23.
1.01	11.00	132	.07	.06	.01	69.	1.01	23.30	282	.02	.02	.00	23.
1.01	11.05	133	.07	.06	.01	69.	1.01	23.35	283	.02	.02	.00	23.
1.01	11.10	134	.07	.06	.01	69.	1.01	23.40	284	.02	.02	.00	23.
1.01	11.15	135	.07	.06	.01	69.	1.01	23.45	285	.02	.02	.00	23.
1.01	11.20	136	.07	.06	.01	70.	1.01	23.50	286	.02	.02	.00	23.
1.01	11.25	137	.07	.06	.01	70.	1.01	23.55	287	.02	.02	.00	23.
1.01	11.30	138	.07	.06	.01	70.	1.02	0.00	288	.02	.02	.00	23.
1.01	11.35	139	.07	.06	.01	70.	1.02	.05	289	0.00	0.00	0.00	14.
1.01	11.40	140	.07	.06	.01	70.	1.02	.10	290	0.00	0.00	0.00	5.
1.01	11.45	141	.07	.06	.01	70.	1.02	.15	291	0.00	0.00	0.00	2.
1.01	11.50	142	.07	.06	.01	71.	1.02	.20	292	0.00	0.00	0.00	1.
1.01	11.55	143	.07	.06	.01	71.	1.02	.25	293	0.00	0.00	0.00	0.
1.01	12.00	144	.07	.06	.01	71.	1.02	.30	294	0.00	0.00	0.00	0.
1.01	12.05	145	.21	.19	.02	126.	1.02	.35	295	0.00	0.00	0.00	0.
1.01	12.11	146	.21	.19	.02	185.	1.02	.40	296	0.00	0.00	0.00	0.
1.01	12.15	147	.21	.19	.03	205.	1.02	.45	297	0.00	0.00	0.00	0.
1.01	12.20	148	.21	.19	.02	213.	1.02	.50	298	0.00	0.00	0.00	0.
1.01	12.25	149	.21	.19	.02	216.	1.02	.55	299	0.00	0.00	0.00	0.
1.01	12.30	150	.21	.19	.02	217.	1.02	1.00	300	0.00	0.00	0.00	0.
									SUM	32.76	29.94	2.82	33576.
										(832.)(	760.)(	72.)(	950.77)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2026.	382.	117.	112.	33601.
CMS	57.	11.	3.	3.	951.
INCHES		24.48	29.94	29.94	29.94
MM		621.72	760.47	760.47	760.47
AC-FT		199.	231.	231.	231.
THOUS CU M		233.	285.	285.	285.

HYDROGRAPH AT STA 30667 FOR PLAN 1, RTIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.

1.	1.	1.	1.	1.	1.	2.	2.	2.	2.
2.	2.	[illegible]	[illegible]	3.	3.	3.	3.	5.	[illegible]
3.	4.	4.	4.	4.	4.	4.	4.	4.	5.
[illegible]	5.	13.	20.	27.	31.	32.	34.	36.	38.
39.	41.	42.	44.	45.	46.	47.	48.	49.	50.
51.	52.	53.	54.	54.	55.	55.	57.	57.	58.
[illegible]	59.	60.	[illegible]	61.	61.	61.	62.	62.	63.
63.	63.	64.	64.	65.	65.	65.	65.	66.	66.
66.	67.	67.	67.	67.	69.	68.	68.	68.	68.
69.	69.	[illegible]	[illegible]	69.	70.	70.	70.	70.	70.
70.	71.	71.	71.	126.	165.	235.	213.	215.	217.
21[illegible]	219.	[illegible]	220.	221.	222.	246.	259.	265.	268.
259.	27[illegible]	272.	271.	271.	272.	272.	273.	300.	328.
338.	341.	343.	344.	344.	345.	345.	345.	345.	346.
233.	320.	[illegible]	493.	629.	1113.	2026.	1959.	1268.	680.
637.	496.	41[illegible]	35[illegible]	336.	330.	328.	329.	327.	327.
329.	[illegible]	324.	[illegible]	331.	272.	267.	259.	258.	258.
258.	258.	256.	254.	259.	258.	167.	71.	39.	29.
25.	24.	23.	23.	23.	23.	23.	23.	23.	23.
23.	23.	23.	23.	23.	23.	23.	23.	23.	23.
23.	23.	23.	23.	23.	23.	23.	23.	23.	23.
25.	23.	23.	23.	23.	23.	23.	23.	23.	23.
23.	23.	23.	23.	23.	23.	23.	23.	23.	23.
23.	23.	23.	23.	23.	23.	23.	23.	23.	23.
23.	3.	23.	23.	23.	23.	23.	23.	14.	5.
2.	1.	0.	[illegible]	0.	0.	[illegible]	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2026.	382.	117.	112.	33601.
CMS	57.	11.	3.	3.	951.
INCHES		24.48	29.94	29.94	29.94
MM		621.72	760.47	760.47	760.47
AC-FT		189.	231.	231.	231.
THOUS CU M		233.	285.	285.	285.

HYDROGRAPH AT STA 30667 FOR PLAN 1, RTIO 2

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	2.	2.	2.
2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
2.	2.	6.	11.	13.	15.	16.	17.	18.	19.
20.	20.	21.	22.	22.	23.	24.	24.	25.	25.
26.	26.	26.	27.	27.	28.	28.	28.	29.	29.
29.	29.	30.	30.	30.	30.	31.	31.	31.	31.
32.	32.	32.	32.	32.	32.	33.	33.	33.	33.
33.	33.	33.	34.	34.	34.	34.	34.	34.	34.
34.	34.	35.	35.	35.	35.	35.	35.	35.	35.
35.	35.	35.	35.	63.	98.	103.	106.	108.	109.
109.	110.	110.	110.	111.	111.	120.	129.	133.	139.
135.	135.	135.	135.	136.	136.	136.	136.	150.	164.
169.	171.	171.	172.	172.	172.	172.	173.	173.	173.
147.	160.	194.	246.	314.	556.	1015.	380.	634.	600.
319.	248.	205.	177.	168.	165.	164.	164.	164.	164.
164.	164.	164.	164.	150.	156.	151.	138.	129.	129.
129.	129.	129.	129.	129.	129.	83.	36.	30.	14.

12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
12.	12.	12.	12.	12.	12.	12.	12.	12.	12.
12.	12.	12.	12.	12.	12.	12.	12.	[illegible]	2.
1.	0.	0.	0.	0.	0.	0.	0.	[illegible]	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1315.	[illegible]	58.	56.	16801.
CMS	[illegible]	5.	2.	2.	476.
INCHES		12.24	14.97	14.97	14.97
MM		310.86	380.24	380.24	380.24
AC-FT		[illegible]	116.	116.	116.
THOUS CU M		117.	143.	143.	143.

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COMBINE HYDROGRAPHS

COMBINE RUNOFF AND UPSTREAM DAM HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
30567	2	0	0	0	0	1	0	0

SUM OF 2 HYDROGRAPHS AT 30567 PLAN 1 RTIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
1.	1.	1.	1.	2.	2.	2.	2.	2.	3.
3.	3.	3.	3.	4.	4.	4.	4.	5.	5.
5.	5.	5.	5.	6.	6.	6.	6.	6.	7.
7.	7.	15.	25.	31.	35.	39.	42.	45.	48.
51.	54.	57.	59.	62.	64.	66.	68.	71.	74.
76.	78.	80.	82.	83.	85.	86.	87.	89.	90.
91.	92.	93.	94.	95.	95.	96.	97.	98.	98.
99.	100.	100.	101.	101.	102.	102.	103.	103.	104.
104.	105.	105.	106.	106.	107.	107.	107.	108.	108.
108.	109.	109.	109.	110.	110.	110.	110.	111.	111.
111.	111.	112.	112.	169.	233.	266.	289.	302.	313.
323.	333.	339.	344.	347.	349.	369.	392.	405.	413.
419.	430.	446.	461.	472.	482.	493.	501.	532.	569.
592.	608.	616.	593.	563.	554.	550.	549.	548.	549.
491.	509.	580.	710.	892.	1481.	2654.	2945.	2308.	1676.
1227.	940.	734.	634.	575.	546.	531.	525.	522.	520.
520.	520.	520.	520.	490.	453.	433.	421.	415.	411.
410.	409.	409.	409.	409.	409.	311.	190.	122.	82.
66.	54.	47.	43.	40.	39.	38.	38.	38.	37.
37.	37.	37.	37.	37.	37.	37.	37.	37.	37.
37.	37.	37.	37.	37.	37.	37.	37.	37.	37.
37.	37.	37.	37.	37.	37.	37.	37.	37.	37.
37.	37.	37.	37.	37.	37.	37.	37.	37.	37.
37.	37.	37.	37.	37.	37.	37.	37.	37.	37.

37.	37.	37.	37.	37.	37.	37.	37.	28.	17.
11.	7.	4.	4.	3.	3.	2.	1.	1.	1.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2945.	611.	184.	179.	13706.
CMS	83.	17.	5.	5.	1521.
INCHES		34.72	30.17	30.17	30.17
MM		527.17	766.28	766.28	766.28
AC-FT		493.	370.	370.	370.
THOUS CU M		374.	456.	456.	456.

SUM OF 2 HYDROGRAPHS AT 33+47 PLAN 1 RTIO 2

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	1.	1.	1.	1.	1.	1.	1.	1.
1.	2.	2.	2.	2.	2.	2.	2.	2.	2.
2.	3.	3.	3.	3.	3.	3.	3.	3.	3.
3.	5.	6.	11.	15.	16.	19.	21.	23.	24.
26.	7.	34.	28.	31.	32.	36.	34.	35.	36.
37.	38.	39.	39.	40.	41.	42.	42.	43.	43.
44.	45.	45.	46.	46.	46.	47.	47.	48.	48.
48.	49.	49.	50.	50.	50.	50.	51.	51.	51.
52.	52.	52.	52.	52.	53.	53.	53.	53.	53.
54.	54.	54.	54.	54.	55.	55.	55.	55.	55.
55.	56.	56.	56.	84.	117.	133.	143.	150.	156.
160.	164.	167.	169.	171.	172.	182.	194.	199.	203.
206.	209.	210.	211.	212.	213.	214.	214.	229.	245.
253.	258.	261.	264.	266.	268.	269.	270.	271.	272.
265.	257.	291.	349.	433.	714.	1342.	1219.	1160.	844.
646.	525.	457.	394.	362.	348.	343.	340.	315.	283.
271.	265.	263.	261.	246.	227.	217.	211.	208.	236.
285.	206.	205.	204.	204.	204.	156.	96.	66.	48.
36.	29.	25.	22.	21.	20.	20.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	14.	8.
6.	4.	3.	2.	2.	1.	1.	1.	1.	1.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1519.	308.	93.	90.	27835.
CMS	43.	9.	3.	3.	788.
INCHES		12.47	15.19	15.19	15.19
MM		316.81	385.73	385.73	385.73
AC-FT		153.	186.	186.	186.
THOUS CU M		189.	230.	230.	230.

B-85

PMF AND ONE-HALF PMF ROUTING

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH HENSON LAKE DAM

IST G	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3.467	1	0	2	0	0	1	0	2

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-708.	-1

STAGE	708.00	709.00	710.50	711.17	712.00	712.57	714.16	715.76	717.26
FLOW	0.00	253.00	601.00	1100.00	2200.00	3570.00	7932.00	13794.00	20230.00
SURFACE AREA=	0.	1.	3.	4.	5.	11.	17.	22.	
CAPACITY=	0.	1.	1.	1.	3.	92.	231.	495.	
ELEVATION=	708.	709.	709.	710.	712.	720.	730.	740.	

CREL	SPWID	COQL	EXPW	ELEVL	CLOSL	CAREA	EXPL
709.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
715.0	0.0	0.0	0.

STATION 30667, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	1.	1.	1.	1.	1.	2.	2.	2.
2.	2.	3.	3.	3.	3.	3.	4.	4.	4.
4.	4.	5.	5.	5.	5.	5.	6.	5.	6.
6.	6.	8.	11.	16.	21.	25.	29.	33.	37.
40.	44.	47.	50.	53.	55.	58.	60.	63.	65.
68.	70.	72.	75.	77.	79.	80.	82.	84.	85.
86.	88.	89.	90.	91.	92.	93.	94.	95.	95.
96.	97.	98.	99.	99.	100.	100.	101.	102.	102.
103.	103.	104.	104.	105.	105.	105.	106.	106.	107.
107.	107.	108.	108.	108.	109.	109.	109.	110.	110.
110.	110.	111.	111.	118.	138.	164.	190.	213.	235.
285.	311.	326.	337.	341.	345.	383.	388.	387.	480.
610.	418.	430.	444.	457.	468.	479.	489.	505.	532.
560.	584.	600.	603.	589.	571.	561.	554.	551.	550.
833.	519.	531.	594.	746.	1054.	2029.	2887.	2585.	1948.
1466.	1093.	917.	755.	645.	586.	558.	540.	531.	525.
522.	821.	820.	520.	511.	488.	461.	441.	427.	419.
914.	411.	410.	409.	409.	409.	380.	380.	226.	199.
171.	145.	122.	103.	89.	75.	66.	59.	53.	49.
46.	44.	42.	41.	40.	39.	39.	38.	38.	38.
38.	37.	37.	37.	37.	37.	37.	37.	37.	37.

37.	37.	37.	37.	37.	37.	37.	37.	37.	37.
37.	37.	37.	37.	37.	37.	37.	37.	37.	37.
37.	37.	37.	37.	37.	37.	37.	37.	37.	37.
37.	37.	37.	37.	37.	37.	37.	37.	36.	32.
27.	22.	17.	14.	11.	9.	7.	5.	4.	3.

STORAGE

14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	16.	15.	16.
16.	16.	16.	16.	15.	15.	16.	16.	15.	16.
16.	16.	15.	16.	16.	16.	16.	16.	16.	16.
16.	16.	16.	16.	15.	16.	16.	16.	16.	16.
16.	15.	16.	16.	16.	16.	16.	15.	16.	16.
16.	15.	16.	16.	16.	17.	19.	18.	19.	20.
20.	20.	20.	20.	20.	20.	20.	21.	21.	21.
21.	21.	21.	21.	21.	21.	21.	22.	22.	22.
22.	22.	22.	22.	22.	22.	22.	22.	22.	22.
22.	22.	22.	22.	23.	25.	29.	31.	30.	29.
27.	25.	24.	23.	23.	22.	22.	22.	22.	22.
22.	22.	22.	22.	22.	22.	21.	21.	21.	21.
21.	21.	21.	21.	21.	21.	21.	20.	19.	19.
18.	17.	17.	16.	16.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.

STAGE

708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2
708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2
708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2
708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2
708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2
708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2
708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2
708.2	708.2	708.3	708.3	708.3	708.3	708.4	708.4	708.4	708.5
708.5	708.5	708.5	708.5	708.5	708.6	708.6	708.5	708.6	708.6
708.7	708.7	708.7	708.7	708.7	708.7	708.8	708.8	708.8	708.8
708.8	708.8	708.8	708.8	708.8	708.8	708.8	708.8	708.8	708.9
708.9	708.9	708.9	708.9	708.9	708.9	708.9	708.9	708.9	708.9
708.9	708.9	708.9	708.9	708.9	708.9	708.9	708.9	708.9	708.9
708.9	708.9	708.9	708.9	708.9	708.9	708.9	709.0	709.0	709.0
709.0	709.0	709.0	709.0	709.0	709.1	709.3	709.5	709.7	709.8
709.9	709.9	710.0	710.0	710.0	710.0	710.0	710.1	710.1	710.1
710.1	710.2	710.2	710.2	710.2	710.2	710.3	710.3	710.3	710.4
710.4	710.5	710.5	710.5	710.5	710.4	710.4	710.4	710.4	710.4
710.4	710.3	710.4	710.5	710.7	711.1	711.9	712.3	712.2	711.8
711.4	711.2	710.9	710.7	710.6	710.5	710.4	710.4	710.4	710.4
710.4	710.3	710.3	710.3	710.3	710.3	710.2	710.2	710.2	710.2

710.1	710.1	710.1	710.1	710.1	710.1	710.1	709.9	709.8	709.6
709.4	[illegible]	709.0	708.9	708.9	708.7	708.7	708.6	708.6	708.5
708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5
708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5
708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5
708.5	708.5	708.5	708.5	708.3	708.5	708.5	708.5	708.5	708.5
708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5
708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.4	708.4
708.4	708.4	708.3	708.3	708.3	708.3	708.2	708.2	708.2	708.2

PEAK OUTFLOW IS 2887. AT TIME 15.67 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2887.	607.	186.	179.	53595.
CMS	82.	17.	5.	5.	1520.
INCHES		24.55	30.16	30.16	30.16
MM		623.55	766.12	766.12	766.12
AC-FT		301.	370.	370.	370.
THOUS CU M		371.	456.	456.	456.

STATION 30667, PLAN 1, RATIO 2

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	1.	1.	1.	1.
1.	1.	1.	1.	2.	2.	2.	2.	2.	2.
2.	2.	2.	2.	3.	3.	3.	3.	3.	3.
3.	3.	4.	6.	8.	10.	13.	15.	17.	19.
20.	22.	24.	25.	27.	28.	29.	30.	32.	33.
34.	35.	36.	37.	37.	38.	39.	40.	41.	41.
42.	43.	43.	44.	44.	45.	45.	46.	46.	47.
47.	48.	48.	48.	49.	49.	49.	50.	50.	50.
51.	51.	51.	51.	52.	52.	52.	52.	53.	53.
53.	53.	53.	54.	54.	54.	54.	54.	54.	55.
55.	55.	55.	55.	59.	70.	84.	98.	110.	121.
130.	137.	144.	150.	154.	158.	163.	168.	175.	181.
186.	191.	194.	198.	201.	203.	205.	207.	210.	216.
223.	230.	243.	255.	261.	265.	267.	269.	270.	271.
263.	256.	267.	299.	355.	465.	854.	1331.	1340.	1033.
825.	650.	545.	472.	416.	390.	360.	309.	336.	314.
292.	277.	269.	264.	258.	245.	232.	228.	224.	220.
217.	215.	213.	211.	210.	209.	202.	185.	161.	137.
114.	94.	77.	63.	52.	44.	37.	32.	29.	26.
24.	23.	22.	21.	20.	20.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	18.	16.
14.	11.	9.	7.	6.	5.	4.	3.	2.	8.

STORAGE

14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
15.	15.	15.	15.	15.	15.	16.	16.	16.	16.
17.	17.	17.	17.	17.	17.	18.	18.	18.	18.
18.	18.	18.	19.	19.	19.	19.	19.	19.	19.
19.	19.	20.	20.	20.	20.	20.	20.	20.	20.
20.	20.	22.	20.	22.	22.	24.	26.	26.	25.
24.	23.	22.	21.	21.	21.	21.	20.	20.	20.
20.	20.	23.	23.	22.	23.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	17.	18.	18.	17.
16.	16.	15.	15.	15.	15.	15.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
14.	14.	14.	14.	14.	14.	14.	14.	14.	14.

STAGE

708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2
708.2	708.2	708.2	708.2	709.2	709.2	708.2	708.2	709.2	708.2
708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	709.2	708.2
708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2
708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2
708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2
708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2	708.2
708.2	708.2	708.2	708.2	708.3	708.3	708.3	708.3	708.3	708.3
708.3	708.4	708.4	708.4	708.4	708.4	708.4	708.4	708.4	708.4
708.4	708.4	708.4	708.5	708.5	708.5	708.5	708.5	708.5	708.5
708.5	708.5	709.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5
708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5	708.5
708.5	708.5	708.6	708.6	708.6	708.6	708.6	708.6	708.6	708.6
708.6	708.6	708.6	708.6	708.6	708.6	708.6	708.6	708.6	708.6
708.6	708.6	708.6	708.6	708.6	708.7	708.8	708.9	709.0	709.0
709.1	709.1	709.2	709.2	709.3	709.3	709.3	709.4	709.4	709.4
709.5	709.5	709.5	709.6	709.6	709.6	709.6	709.6	709.6	709.7
709.7	709.8	709.8	709.8	709.9	709.9	709.9	709.9	709.9	709.9
709.9	709.8	709.9	709.9	710.0	710.3	710.8	711.3	711.4	711.1
710.8	710.6	710.4	710.3	710.1	711.1	710.0	710.0	710.0	710.0
709.9	709.9	709.9	709.9	709.8	709.8	709.8	709.8	709.7	709.7
709.7	709.7	709.7	709.6	709.6	709.6	709.6	709.5	709.3	709.1
709.0	708.8	708.7	708.6	708.6	708.5	708.5	708.4	708.4	708.4
708.4	708.4	708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3
708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3
708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3
708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3
708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3

B-51

708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3	708.3
708.3	708.3	708.3	708.2	708.2	708.2	708.2	708.2	708.2	708.2

PEAK OUTFLOW IS 1340. AT TIME 15.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1340.	305.	94.	90.	27027.
CMS	38.	9.	3.	3.	765.
INCHES		12.37	15.18	15.18	15.18
MM		313.30	385.62	385.62	385.62
AC-FT		151.	186.	186.	186.
THOUS CU M		187.	230.	230.	230.

********** ********** ********** ********** **********

PLAN FLOW AND STORAGE (NO OF [illegible]) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS	
				RATIO 1 1.00	RATIO 2 .57
HYDROGRAPH AT	/S DAM	.22	1	1159.	578.
		(.22)		(32.82)	(16.41)
ROUTED TO	/S DAM	.09	1	1091.	578.
		(.23)		(30.90)	(16.36)
ROUTED TO	S -0/S	.09	1	1046.	533.
		(.23)		(29.64)	(15.24)
HYDROGRAPH AT	30667	.15	1	1026.	1014.
		(.38)		(57.37)	(28.64)
2 COMBINED	30667	.23	1	2945.	1519.
		(.60)		(83.39)	(43.02)
ROUTED TO	30667	.23	1	2667.	1380.
		(.60)		(81.76)	(37.93)

B-55

SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ***********

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	740.00	742.00	745.00
STORAGE	0.	0.	0.
OUTFLOW	0.	0.	1498.

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	745.54	.54	9.	1091.	.58	15.67	13.42
.50	744.03	.03	10.	478.	.18	15.67	15.50

PLAN 1 STATION S HD/S

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	1040.	724.7	15.75
.50	539.	723.6	15.67

B-54

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	706.20	706.20	71 .00
STORAGE	14.	14.	20.
OUTFLOW	0.	0.	339.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	712.33	2.33	31.	2887.	5.25	15.67	0.00
.50	711.37	1.37	24.	1340.	1.17	15.75	0.00

B-25

PERCENT OF PMF FLOOD ROUTING
EQUAL TO SPILLWAY CAPACITY

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****************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
 LAST MODIFICATION  26 FEB 79
****************************************
A1                     DAM SAFETY INSPECTION - MISSOURI
A2                        BENSON LAKE DAM (MO 30667)
A3                            PERCENT PMF
B     300       0       5       0       0       0       0       0      -4       0
B1      5
J       1       4       1
J1    .15     .17     .18     .20
K       0 U/S DAM                                       1
K1      RUNOFF CALCULATION FOR U/S DAM DRAINAGE AREA
M       1       2    .035            .035       1                       1
P            25.2     130     130     130
T                                                      -1     -80
W            .038
X       0       0       1
K       1 U/S DAM                                       1
K1       ROUTE HYDROGRAPH THROUGH U/S DAM
Y                               1       1
Y1      1                                            -742      -1
Y4    742     743  744.56   745.2  745.76   746.6  747.28  748.78  750.28
Y5      0      20     100     170     330     750    1361    3424    6100
$A      0       1       2     4.5       6       7
$E    770     740     747     750     770     780
$S    742
$D    745
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B-~~67~~ 58

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Y9   10      .5     738       1     740     745
K        10/S -D/S                                    1
K1        CHANNEL ROUTING
Y                                   1       1
Y1    1
Y6  .05     .05     .05     720     740    1000    .025
Y7          740      40     730      90     723      95     720     105     720
Y7  110     723     190     730     250     740
K     0   30667                                       1
K1  RUNOFF CALCULATION FOR BENSON LAKE DAM RUNOFF AREA
M     1       2    .145            .145       1                     1
P          25.[illegible]     120     120     130
T                                                    -1     -80
W2          .382
X     0       0       1
K     2   30667                                       1
K1        COMBINE RUNOFF AND UPSTREAM DAM HYDROGRAPH
K     1   30667                                       1
K1  ROUTE HYDROGRAPH THROUGH BENSON LAKE DAM
Y                                   1       1
Y1    1                                          -708.2      -1
Y4 708.2  709.8   710.5  711.17     712  712.57  714.16  715.76  717.26
Y5    0     233     600    1100    2200    3370    7932   13794   23238
$A    0      .5       3       4       5      11      17      22
$E   [illegible]   700   708.2   709.5     712     720     733     740
$S 710.2

SD   710
A     99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	#S DAM
ROUTE HYDROGRAPH TO	#S DAM
ROUTE HYDROGRAPH TO	#S-(#)
RUNOFF HYDROGRAPH AT	30667
COMBINED HYDROGRAPHS AT	30667
ROUTE HYDROGRAPH TO	30667
END OF NETWORK	

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**************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  26 FEB 79
**************************************

RUN DATE = 80/06/04.
    TIME = [illegible]

                    DAM SAFETY INSPECTION - MISSOURI
                      FENSON LAKE DAM (MO 30667)
                        [illegible]

                         JOB SPECIFICATION
   NQ     NHR    NMIN    IDAY    IHR    IMIN   METRC   IPLT   IPRT   NSTAN
  300      0      [illegible]     0      0      0       0     [illegible]    -4      0
                        JOPER    NWT   LROPT   TRACE
                          5       0      0       0

                 MULTI-PLAN ANALYSES TO BE PERFORMED
                   NPLAN= 1  NRTIO= [illegible]  LRTIO= 1
   RTIOS=    .15    .17    [illegible]    [illegible]

**********     **********     **********     **********     **********

                   SUB-AREA RUNOFF COMPUTATION

   RUNOFF CALCULATION FOR U/S DAM DRAINAGE AREA

           ISTAQ   ICOMP   IECON   ITAPE   JPLT   JPRT   INAME  ISTAGE   IAUTO
           U/S DAM    0       0       0      0      0      1       0       0

                        HYDROGRAPH DATA
   IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
     1       2     .09     0.00    .09    1.00    0.000     0       1       0

                          PRECIP DATA
          SPFE     PMS      R6      R12     R24      R48     R72     R96
          0.00   25.20  100.00  120.00  130.00    0.00    0.00    0.00

                           LOSS DATA
   LROPT  STRKR  DLTKR  RTIOL  ERAIN  STRKS  RTIOK  STRTL  CNSTL  ALSMX  RTIMP
     0     0.00   0.00   1.00   0.00   0.00   1.00  -1.00 -80.00   0.00   0.00

   CURVE NO =  -80.00  WETNESS =   -1.00  EFFECT CN =   80.00

                      UNIT HYDROGRAPH DATA
                   TC=  0.00     LAG=   .09

                         RECESSION DATA
            STRTQ=    0.00   QRCSN=   0.00    RTIOR= 1.00

      0                     END-OF-PERIOD FLOW
 MO.DA  HR.MN  PERIOD  RAIN  EXCS  LOSS   COMP Q     MO.DA  HR.MN  PERIOD  RAIN  EXCS  LOSS   COMP Q
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61
B-70

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                                                              SUM  32.76   29.54    2.82     19714.
                                                                  ( 832.)( 760.)(  72.)(  558.24)

  ..........          ..........          ..........          ..........          ..........

                                         HYDROGRAPH ROUTING

                      ROUTE HYDROGRAPH THROUGH U/S DAM

                          ISTAQ   ICOMP   IECON   ITAPE    JPLT     JPRT   INAME  ISTAGE   IAUTO
                          U/S DAM     1       0       0       0        0       1       0       0
                                                ROUTING DATA
                   QLOSS   CLOSS     AVG   IRES   ISAME    IOPT     IPMP           LSTR
                     0.0   0.000    0.00      1       1       0        0              0

                          NSTPS   NSTDL     LAG   AMSKK       X      TSK   STORA  ISPRAT
                              1       0       0   0.000     0.0    0.000   -742.     -1

   STAGE      742.00    742.00    744.50    745.00    745.50    746.00    747.20    748.78    750.00

   FLO.          .00     25.00    130.00    170.00    370.00    750.00   1361.00   3424.00   6100.00

 SURFACE AREA=      0.        1.        2.        5.        7.        7.

    CAPACITY=       0.        4.       11.       53.      105.      170.

   ELEVATION=     730.      742.      747.      760.      770.      780.

                          CREL    SPWID    COQW    EXPW    ELEVL    COOL    CAREA    EXPL
                          742.0     0.0     0.0     0.0     0.0     0.0      0.0      0.0

                                                  DAM DATA
                                         TOPEL    COQD    EXPD   DAMWID
                                         745.0     0.0     0.0       0.

                                                 DAM BREACH DATA
                                  BRWID        Z    ELBM    TFAIL     WSEL   FAILEL
                                    10.      .50  738.00     1.00   742.00   745.00

PEAK OUTFLOW IS      104. AT TIME  15.75 HOURS

PEAK OUTFLOW IS      127. AT TIME  15.75 HOURS

PEAK OUTFLOW IS      137. AT TIME  15.75 HOURS

BEGIN DAM FAILURE AT 15.75 HOURS

PEAK OUTFLOW IS      159. AT TIME  15.75 HOURS

  ..........          ..........          ..........          ..........          ..........
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B-67

HYDROGRAPH ROUTING

CHANNEL ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
S-[illegible]	1	0	[illegible]	0	[illegible]	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	[illegible]		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0[illegible]	.0[illegible]	.[illegible]	720.0	740.0	1000.	.02[illegible]

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
[illegible] [illegible] 40.00 73[illegible] 40.00 72[illegible] 95.00 720.00 1[illegible].00 720.00
11[illegible] [illegible] 1[illegible] [illegible] 2[illegible] 740.00

STORAGE	0.0	.[illegible]	.6	1.11	1.6F	3.08	4.72	6.73	9.30	12.25
	15.6[illegible]	19.26	23.22	27.44	31.95	36.73	41.79	47.13	52.75	58.65
OUTFLOW	0.00	53.46	182.55	386.70	749.57	1324.89	2181.01	3376.07	4962.69	6989.72
	9575.01	12738.81	16401.67	20584.81	25306.43	30585.25	36440.21	42890.35	49954.69	57652.15
STAGE	720.00	721.05	722.11	723.16	724.21	725.26	726.32	727.37	728.42	729.47
	730.53	731.58	732.63	733.68	734.74	735.79	736.84	737.89	738.95	740.00
FLOW	0.00	53.46	182.55	386.70	749.57	1324.89	2181.01	3376.07	4962.69	6989.72
	9575.01	12738.81	16401.67	20584.81	25306.43	30585.25	36440.21	42890.35	49954.69	57652.15

MAXIMUM STAGE IS 721.5

MAXIMUM STAGE IS 721.6

MAXIMUM STAGE IS 721.7

MAXIMUM STAGE IS 721.9

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF CALCULATION FOR BENSON LAKE DAM RUNOFF AREA

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
30667	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.1[illegible]	0.00	.1[illegible]	1.00	[illegible].000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.2[illegible]	100.00	[illegible]20.00	130.[illegible]	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
[illegible]	0.0[illegible]	[illegible].00	1.0[illegible]	.[illegible]	[illegible].00	1.00	-1.00	-[illegible]0.03	0.00	0.00

CURVE NO = -[illegible]0.00 WETNESS = -1.00 EFFECT CN = [illegible]0.00

UNIT HYDROGRAPH DATA
TC= 0.[illegible] LAG= .[illegible]

RECESSION DATA
STRTQ= [illegible].00 QRCSN= [illegible] RTIOR= 1.00

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	32.76	29.94	2.82	33576.
										(832.)(	760.)(	72.)(	950.77)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE RUNOFF AND UPSTREAM DAM HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
30657	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH HENSON LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
30667	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-788.	-1

STAGE	708.2[illegible]	709.80	710.50	711.17	712.00	712.67	714.16	715.76	717.26
FLOW	0.00	235.00	600.00	1100.00	2200.00	3570.00	7932.00	13794.00	20238.00
SURFACE AREA=	0.	1.	3.	4.	5.	11.	17.	22.	

CAPACITY=	0.	1.	1=.	18.	3C.	92.	231.	425.
ELEVATION=	695.	70?.	708.	710.	71?.	720.	730.	740.

CSEL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
70?.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
710.0	0.0	0.0	0.

PEAK OUTFLOW IS 241. AT TIME 15.?? HOURS

PEAK OUTFLOW IS 303. AT TIME 15.23 HOURS

PEAK OUTFLOW IS 540. AT TIME 1?.?? HOURS

PEAK OUTFLOW IS 398. AT TIME 15.?? HOURS

B-55

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PEAK FLOW AND STORAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 .15	RATIO 2 .17	RATIO 3 .18	RATIO 4 .20
HYDROGRAPH AT	/S DAM	.09 (.23)	1	174. (4.92)	197. (5.57)	209. (5.91)	232. (6.56)
ROUTED TO	/ DAM	.09 (.23)	1	174. (4.92)	197. (5.60)	197. (5.57)	197. (5.44)
ROUTED TO	S -D/S	.09 (.23)	1	103. (2.92)	134. (3.79)	134. (3.78)	157. (4.45)
HYDROGRAPH AT	37667	.15 (.39)	1	304. (8.60)	344. (9.75)	365. (10.33)	405. (11.47)
2 COMBINED	37667	.23 (.60)	1	374. (10.58)	424. (12.03)	451. (12.76)	505. (14.30)
ROUTED TO	37667	.23 (.60)	1	241. (6.82)	303. (8.58)	340. (9.64)	398. (11.27)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ***************

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	742.00	742.00	745.00
STORAGE	4.	4.	8.
OUTFLOW	0.	0.	148.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.15	744.59	0.00	7.	104.	0.00	15.75	0.00
.17	744.81	0.00	7.	127.	0.00	15.75	0.00
.19	744.98	0.00	8.	137.	0.00	15.75	0.00
.20	745.07	.07	8.	159.	.15	15.79	15.75

PLAN 1 STATION S -D/S

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.15	132.	721.5	15.83
.17	147.	721.6	15.83
.19	134.	721.7	15.83
.20	147.	721.9	15.83

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	705.10	706.20	710.00
STORAGE	14.	14.	20.
OUTFLOW	0.	0.	338.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	AT DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.15	709.62	0.00	20.	241.	0.00	15.83	0.00
.17	709.93	0.00	20.	303.	0.00	15.83	0.00
.18	710.07	.07	20.	340.	.00	15.75	0.00
.20	710.11	.11	21.	398.	.17	15.75	0.00

B-19

END

DATE
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